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REPLACEMENT OF THE FEMORAL HEAD BY A PROSTHESIS FOR RECONSTRUCTION OF THE HIP JOINT

A Report on the Judet Method

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FOR a long time, the orthopedic surgeon has been searching for a method of treatment that would ensure uniformly satisfactory results in the many refractory lesions encountered at the hip joint in both young and old adults. With the introduction of the ingenious method of prosthetic reconstruction, devised by Jean and Robert Judet of Paris, there has been an entirely new and notable development in the domain of surgery of the hip joint. This new technique, replete with manifest possibilities, may well prove to be the effective solution of treatment for the many painful and crippling lesions of the hip joint, in which the classical procedures in use still fail to give results which are completely satisfactory.

The writer became enthusiastic about this method after seeing several operations performed by the Judet brothers in Paris, and by Verbrugge in Antwerp, and after examining many of the patients of all three surgeons. Much credit should be given to the Judets for pioneering in this field of surgery, and for their courage to develop and adapt the prosthetic method. Experience with the procedure now extends over a period of close to 4 years. The results have been remarkably satisfactory, and one feels convinced that the method will continue to prove itself in the future. The writer left Paris with the deep impression of having seen the most constructive development in hip surgery in the past 30 years.

The object of this paper is to focus further attention upon the replacement method and to encourage unreserved consideration of the procedure. Illustrative cases of the writer's experience with the method in 26 cases are included, in all of which the immediate results have been extremely favorable.

Fig. 1. Line of incision.
Fig. 2. Incision through the capsular ligament.
Fig. 3. Dissection of the capsular ligament away from the femoral neck.
Fig. 4. Retraction of muscles and dislocation of the femoral head.
Fig. 5. Osteotomy at the junction of the femoral head and neck.
Fig. 6. Deepening of the acetabulum with a Hudson reamer.
Fig. 7. Drilling of the neck of the femur in preparation for the introduction of the prosthesis.
Fig. 8. Introduction of the Judet cutter for shaping the femoral neck.
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Fig. 11. a and b, Introduction of the prosthesis.
Fig. 12. The prosthesis in position.

REFRACTORY LESIONS OF THE ADULT HIP JOINT

Foremost among the challenging problems is osteoarthritis of the hip (also referred to as hypertrophic arthritis, degenerative arthritis, arthritis deformans, and morbus coxae senilis). The lesion develops usually in patients between 45 and 50 years of age, is definitely progressive in character, and often bilateral (Case 3). Pain is frequently severe, motion becomes limited gradually, permanent deformities may develop, and total loss of function eventually ensue. The underlying factor is, undoubtedly, trauma of the joint incident to overuse and abuse of the hip. Hence, the lesion is common among persons whose work requires constant standing, walking, or jumping on and off trucks. The farmer, who plows uneven ground, is particularly predisposed to the lesion.

Another real problem is presented by the intracapsular fracture that fails to unite (Case 6), or which is followed by avascular necrosis of the femoral head or the development of an arthritic process, even though the fracture is solidly united (Cases 1 and 8). In all cases of nonunion, an arthritic process develops as the result of the defective mechanics of the joint, accounting to a large extent for the pain.

The fresh intracapsular fracture still remains the "unsolved problem." All surgeons complain of the high percentage of nonunion and avascular necrosis of the femoral head under every type of treatment.

There is also a fairly large group of cases, in which arthritic changes of the hip joint develop secondary to defective mechanics as the result of a congenital lesion or a lesion acquired in early life. The involved joint may function well for a number of years, and the defect is not uncovered until later in life, at about 40 years of age, when the patient seeks relief from pain, restriction of motion, and a limp. Upon examination, the femoral head and neck may be found to be grossly deformed, the acetabulum shallow, or an avascular necrosis of the femoral head may have developed. In some cases, the lesion may have been recognized and satisfactorily treated in childhood, but secondary arthritic changes develop as the result of lack of conformity between the articular surfaces. The patients in this group, who are in middle life, are considerably handicapped by the restricted motion and a limp.

In long standing unreduced dislocations of congenital origin, the situation is critical, particularly if the lesion is bilateral. The shortening and anteversion of the femoral neck may be considerable, and the head may be undeveloped or deformed, often riding 3 or 4 inches above a rudimentary acetabulum. The patient walks with an extreme wobble and is definitely crippled.

Not infrequently, in congenital dislocations that were reduced in early childhood, "wear and tear" changes develop in later life, causing increasing pain and stiffness in one or both hips (Case 5). In other reduced cases, aseptic necrosis of the femoral head may develop, giving rise to disabling symptoms as early as 35 years of age. If the necrosis is bilateral, a serious problem is presented.

Perthes' disease (Case 7), or a poorly reduced epiphyseal displacement, may be the underlying cause of deranged joint mechanics. Even in cases of displacement that were apparently well reduced, the femoral head may become deformed and the neck enlarged, or an avascular necrosis may develop, or an osteoarthritic process ensue in later years. The secondary changes become evident 15 or 20 years after childhood, when the symptoms of increasing pain and stiffness appear.

Mechanical difficulties at the hip joint similar to those in epiphyseal lesions may develop in long standing rachitic lesions.

Derangement of the joint may also be traumatic in origin, secondary to a long standing fracture or dislocation (Case 2). In the latter case, atrophic necrosis of the femoral head is common.

Finally, a problem is presented when both hips are ankylosed as the result of sepsis. It is true that one hip, when stiff in good position, is a serviceable member, but when a person has two stiff hips, he is definitely crippled.

CLASSICAL PROCEDURES OF TREATMENT

The number of operative procedures proposed for the treatment of these lesions of the hip joint and designed to relieve pain, correct deformity, re-establish stability, restore mo-

tion, and repair the ununited fracture of the neck of the femur, has been manifold. No procedure has offered a complete solution. No procedure has been universally accepted.

In the treatment of the osteoarthritic hip and the painful, stiff, unstable hip due to defective mechanics of the joint, 5 procedures have been most widely used: denervation, osteotomy, pseudarthrosis, arthrodesis, and arthroplasty.

Since pain is the most common and persistent cause of suffering, denervation of the joint, either by neurectomy or capsulectomy, has been advocated. Neither the cutting of nerves nor the excision of capsule has proved to be consistently satisfactory treatment. The results are uncertain; pain may be relieved in some cases, but in others, relief is only temporary. The procedure fails, in fact, to attack the basic problem. Its limited application is recognized even by Tavernier, who considers neurectomy the basis of treatment of the osteoarthritic hip. The only indication for denervation is in the elderly patient, who has severe pain and is not in condition to undergo more extensive surgery.

Osteotomy of the simple corrective type, displacement osteotomy of the high subtrochanteric type or the low subtrochanteric type, and intertrochanteric osteotomy have been used in treating osteoarthritis. Osborne and Fahrni recently made an interesting study of the redistribution of the stresses on the hip joint in the McMurray osteotomy with displacement, which has been rather widely used and has yielded some satisfactory results. The procedure, however, has a limited application, since all joints are not suitable for osteotomy. There is also no assurance that the range of motion will be improved under this treatment. Moreover, the prolonged period of immobilization required is an objectionable feature, particularly if the patient is elderly, as motion at the knee joint is likely to be jeopardized.

In England, the so called pseudarthrosis operation, suggested by Girdlestone and consisting of the excision of the femoral head and neck and conditioning of the acetabulum, has met with considerable success. Pain has been relieved, stability re-established, deformity corrected, and a useful range of motion restored. Taylor recently reported the results in 93 cases, 83 of which were considered good. To obviate the danger of instability, which is recognized as a drawback of the operation, Batchelor supplemented the procedure by a low subtrochanteric osteotomy, or advised wearing a caliper. The shortening of the extremity, which increases with weight-bearing, is another drawback. There is also the danger that deformity will recur.

Arthrodesis has long been considered one of the most satisfactory procedures for relieving the chronic arthritic hip. When the fusion is sound, the patient obtains a joint that is solid, stable, and painless, but stability is obtained at the sacrifice of motion. Moreover, the results of arthrodesis are not at all certain, for it is not easy to establish a good bony fusion. The procedure also necessitates an extended period of postoperative immobilization, which is not well tolerated by the elderly person and which endangers motion at the knee joint. A still further disadvantage is the contraindication to the operation if the lesion is bilateral, or likely to become bilateral, or if the lumbar spine is stiff or arthritic. The advisability of using this procedure in a young adult is also questionable.

Many earnest efforts have been made to relieve pain and instability and at the same time to restore motion at the hip joint, by arthroplasty. Regardless of the technique used, this operation has not proved successful in restoring a painless and functional degree of motion at the hip joint, as in ankylosed knee and elbow joints. The term "arthroplasty" is here used in a restricted sense, defining a mobilizing procedure in which some substance, such as fascia lata, is interposed between the joint surfaces. In the majority of cases, the functional results of arthroplasty of the hip joint are mediocre, mobility being limited and painful. In some cases a useful degree of motion is restored, but the joint is unstable.

The explanation of the failure of arthroplastic procedures at the hip joint lies to a great extent in the load that the joint must carry in weight-bearing. Certain details of technique may also be responsible, such as the use of an interposing substance that is not durable, and the removal of the femoral head from the ace-

tabulum and reaming out a new cavity, which cause traumatization sufficient to give rise to the development of intra-articular spurs. A complicating periarthritis also tends to develop in hip joints that are mobilized by arthroplasty.

During recent years, the metallic cup arthroplasty has had a period of vogue. This method has not yet proved itself. The chief difficulty with the procedure is a mechanical one, the metallic substitute for the articular femoral surface being mobile and unstable in its relationship to both the acetabulum and the femoral head. Other drawbacks of the method are the difficulty of application when the head and neck are grossly deformed; the possibility of absorption of the head and neck, due to interference with the blood supply; and the prolonged postoperative treatment, which the more elderly patient withstands only with difficulty.

In the treatment of nonunion of fractures of the femoral neck, Whitman's reconstruction operation has been one of the accepted procedures. The results of this procedure, although fairly consistent, are far from satisfactory. The joint remains mobile, but motion is limited to less than the right angle, and it is never painless motion. The patient walks with a limp. The hip also tends to become less functional as time goes on, and the extremity may assume the position of adduction deformity. Ankylosis may ensue with the extremity in faulty position.

This method fails because the joint is not satisfactorily reconstructed from the standpoint of good mechanics. The femoral neck is considerably smaller than the acetabulum with which it articulates, making for instability. The cervical stump fails, at times, to reach well within the acetabulum, with the result that the extremity tends to assume the position of adduction deformity. Furthermore, the joint surface created by the resection becomes irregular, and periarticular changes develop. There is also the danger of absorption of the femoral neck.

Bone-grafting in the hands of the highly trained surgeon has afforded some satisfactory results in ununited fractures of the neck of the femur. There is always the danger, however, that union may not occur because of the avascular condition of the femoral head.

Subtrochanteric osteotomy has resulted in union in a certain proportion of cases. In a recent study by King of the results in 24 ununited fractures treated by a combined operation of nailing and subtrochanteric osteotomy, the fractures were found to have united in 79.2 per cent of the cases, and the osteotomy had united in all cases. Union of the fracture was found to be essential to the recovery of a functional, painless hip.

The large variety of methods used in treating fresh intracapsular fractures of the neck of the femur, from the time when the Whitman abduction method was the accepted treatment, calls for no review. Under the Whitman method of treatment, bony union was obtained in approximately 60 per cent of the cases, so called fibrous union in 20 per cent, and nonunion in from 20 to 25 per cent. With the use of mechanical fixation, there has been little change in the percentage of union. King, in a recent study of end-results, found that, with internal fixation by nails, the majority of surgeons obtain union in from 70 to 80 per cent of their cases, and avascular necrosis develops later in 25 per cent of the cases. There is little difference, according to King's report, in the percentage of union when supplementary bone grafts are used (71%), when both nailing and primary osteotomy are carried out (69%), and when primary osteotomy alone is used (72%). In King's experience, the percentage of avascular necrosis was considerably lower after primary osteotomy than after internal fixation alone or nailing and grafting.

In the treatment of congenital dislocation of the hip of long standing, an operation of the shelf type or arthrodesis is the accepted method. As a rule, a functional joint is not obtained by either of these procedures, and the hip is painful.

PROSTHETIC REPLACEMENT OF ARTICULAR EXTREMITIES

The idea of substituting an articular extremity by a prosthesis, including the femoral head, is not new. Credit for the first systematic attempts to replace a loss of bony substance should be given to Delbet, who utilized

prostheses of reinforced rubber in 7 cases. In 6 cases the prostheses replaced diaphyseal segments, but in 1 case, the upper extremity of the humerus was replaced by a prosthesis following resection for sarcoma. The replacement had been well tolerated up to 7 months after the operation, when the patient died of metastasis.

In 1926, Robineau reported the case of a benign tumor of the lower end of the humerus in which, following resection, a prosthesis of rubber reinforced with steel was used. The following year, Robineau used a prosthetic piece in the upper third of the femur in the case of a recent fracture. In the case of the humerus, the joint remained stable and functional, and the prosthesis was well tolerated, 2 years after the operation. In the second case, the fixation proved defective.

Hey Groves suggested replacing an inflamed or ankylosed femoral head by a large ivory nail, which was inserted through the femoral neck into the shaft.

In 1943, Moore and Bohlman reported a case of cystic degeneration of the upper end of the femur, in which the entire proximal third was resected and replaced by a vitallium appliance 12 inches in length. Following a diaphyseal fracture at the seat of fixation, the prosthesis was reinserted. One year after the operation, the patient was walking well without a cane, and the prosthesis had been tolerated perfectly.

In 1946, Hudack, having the idea of articular replacement in mind, experimented with dogs, using a flanged nail fixation seated in the medullary canal at the shoulder joints.

One year later, Delitala reported on the attempts at prosthetic replacement at the Rizzoli Institute of the University of Bologna. In 1935, an aluminum prosthesis was used in an arthroplasty of the knee joint but ended in failure. During the years 1942 to 1946, prostheses of stainless steel were used in 7 cases, temporarily in 2 cases and definitively in 5 cases. In all cases, extensive bony resections had been necessary for malignant tumors. In 4 of the 5 definitive substitutions, the prosthesis was adapted to an articular extremity, in 2 cases at the upper humerus, in 1 case at the upper femur, and in 1 case at the lower femur. To obviate bony rarefaction and fracture at the seat of fixation, grips with blades fixed by means of screw bolts were used. The metallic head was of the same form and dimensions as the head removed, and retention was obtained by suturing of the capsule. In the case of the upper femur, the prosthesis had to be removed because of suppuration; in 1 case of the upper humerus, the prosthesis was perfectly tolerated for 14 months, and the patient, a child of 5 years, had a completely functional arm; and in the second case of the upper humerus, the shoulder had limited motion 8 months after the operation. The fourth patient died of pulmonary metastasis 6 months after the lower femur had been replaced.

In 1947, Mellon and Phalen reported 4 cases in which acrylic prostheses were used to replace the distal portion of the humerus. One was a case of a large defect, and 3 cases were ununited fractures in the supracondylar region. The prostheses were molded from a functional standpoint without regard for normal anatomical form. Three of the 4 patients were observed for a period of from 9 to 18 months. A limited range of motion was regained, the joints were comparatively stable, and pain was negligible.

In recent years in this country, several surgeons including McBride, Jaenichen, and Nickerson have been using prostheses in the treatment of hip lesions. No reports of this recent work seem to have been published

JUDET METHOD OF PROSTHETIC RECONSTRUCTION

Application of the method. It is in the large field of osteoarthritic hips that the Judet operation has its broadest application. The procedure should always be considered whenever, despite conservative treatment, pain persists and a person's activities are restricted by the lesion. The operation is especially indicated when both hips are stiff, and in cases in which deformity has developed.

It is an ideal procedure for treating the mechanically defective hip joint that is painful and limited in mobility as the result of a juvenile epiphyseal lesion, such as Perthes' disease or an epiphyseal displacement. It may be indicated in cases with faulty mechanics second-

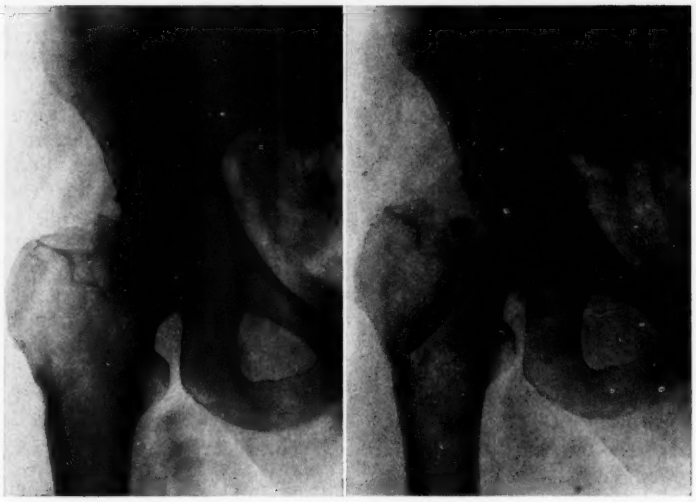

Fig. 13, left. Case 1. E.M. Roentgenogram showing avascular necrosis of the femoral head, absorption of the neck, and spur formations, approximately 1 year after fracture of the neck of the femur. The fracture had united following internal fixation.
Fig. 14. Case 1. E.M. Roentgenogram taken 2 months after replacement operation.

ary to a rachitic lesion or an old traumatic dislocation.

The method is applicable to ununited fractures of the neck of the femur, even though the neck is completely absorbed. Likewise, it is indicated when avascular necrosis of the femoral head occurs. It should be considered when, following a fracture of the neck of the femur with union, the symptoms of pain, stiffness, and limited motion progress in spite of the usual conservative measures.

The method has a certain application in fresh fractures of the neck of the femur in the elderly whose life expectancy is short. The Judets, Enel, and Verbrugge have used the operation in such cases with success. Should this method ever come to be used routinely in recent fractures of the neck of the femur, it would entirely revolutionize the treatment, eliminating such complicating sequelae as nonunion, malunion, avascular necrosis, and arthritis.

The method may be used in cases in which necrosis of the femoral head develops later in life in congenital dislocation, which was successfully reduced in childhood.

A person with an unreduced congenital dislocation of the hip, and who is under 30 years of age, may benefit from this procedure. The correction of such long standing dislocations has always proved difficult by the usual methods of treatment.

The Judet operation is suitable as a method to restore mobility in cases of bilateral ankylosis from sepsis.

The procedure may also be considered in cases of destruction of the femoral head by a cystic formation; in cases of pathological luxation of long standing; and in cases of septic arthritis of infancy when the head has already been destroyed.

Age is not a contraindication, provided the patient is in good general condition. This advantage is due to the fact that the operation itself is not destructive, and is less shock-producing than most surgical procedures at the hip joint.

Operative technique. The operative procedure varies to a certain extent in accordance with the lesion under treatment and the pathological process uncovered. In the description of the technique that follows, note is made of the varying details of the procedure.

Perfect hemostasis is essential.

An operating table that may be raised in the pelvic region is used which, in permitting

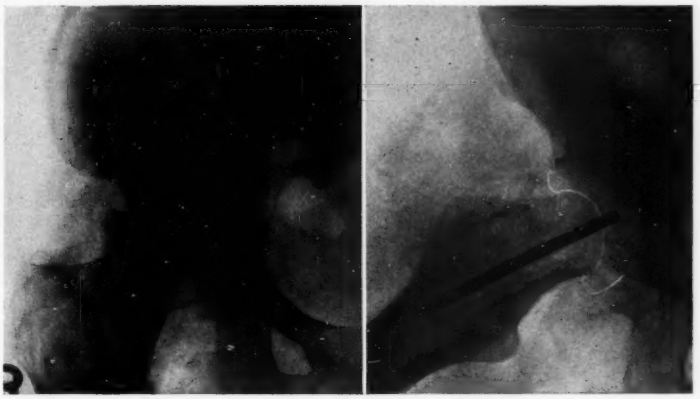

Fig. 15, left. Case 2. J.J. Roentgenogram showing aseptic necrosis of the femoral head and arthritic spurs 10 years after traumatic dislocation of the hip.
Fig. 16. Case 2. J.J. Roentgenogram taken 3 weeks after replacement operation.

hyperextension of the extremity, provides for better exposure of the osteotomized neck of the femur. The hip is prepared with the entire extremity left free to permit manipulation.

Exposure: A longitudinal incision of the Hueter type is made on the anterior and outer third of the thigh, extending downward from the anterior superior spine for a distance of from 6 to 8 inches (Figs. 1 to 12, frontispiece). The lateral femoral cutaneous nerve is identified. The incision is carried down through the aponeurosis between the tensor fasciae latae and sartorius and then passes to the outer side of the rectus femoris. In the lower part of the wound, the ascending branch of the lateral femoral circumflex artery may require ligature.

The sartorius and rectus femoris are retracted to the inner side, and the tensor fasciae latae is retracted to the outer side, so that the capsular ligament is exposed. With the blunt dissector of Judet, the capsule is freely exposed in its anterior, upper, and lateral aspects.

The handling of the capsule depends upon its condition. It always shows some pathological change and may be adherent to the femoral neck, but if the capsule appears to be fairly normal, steps are taken to preserve it. In the Judet technique, a cruciate incision is made, and the 4 flaps of capsule thus created are retracted. The writer first makes a longitudinal incision running down the middle of the femoral neck from the acetabulum to the lower capsular attachment, and then a transverse incision across the base of the first incision (Fig. 2). One flap of capsule is retracted medially and the other laterally, and the flaps are preserved for resuture (Fig. 3). A double chromic catgut suture may be passed through the flaps to permit suturing the capsule in proper place at the close of the operation.

As a rule, the capsule is edematous, thickened, and infiltrated, and its inner surface is covered with red, villous granulation. The Judets advise excision of the entire anterior capsule in such cases. In my opinion, the tension on such pathologic capsule causes pain, and its ablation accounts to a great extent for the freedom from pain after the Judet operation.

In long standing nonunion of the femoral neck, the posterior capsule is contracted and maintains the head in external rotation. In such lesions, the insertion of the capsule should be detached in its posterior aspect.

Removal of the femoral head: The lesion being treated and the pathological condition determine the next step. If the case is one of an arthritic hip and the pathological process is not extensive, it is possible to dislocate the femoral head from the acetabulum by forcibly flexing, adducting, and rotating the extremity externally, the head of a Lambotte's retractor being used in the joint as a lever (Fig. 4). The head is then excised at the junction of the articular cartilage and the neck (Fig. 5).

Fig. 17, left. Case 3. G.B. Roentgenogram showing severe osteoarthritis and the presence of a foreign body.
Fig. 18. Case 3. G.B. Roentgenogram taken 6 weeks after removal of the foreign body and replacement of the femoral head by a prosthesis.

When the structural changes are extensive, as in an advanced arthritic process in which the head is misshapened, the neck thickened, and there are numerous overlapping acetabular spurs, it is usually advisable to perform an osteotomy at the junction of the head and neck. Before this step is undertaken, the overlapping acetabular spurs should be removed and an attempt made to dislocate the head. If any difficulty is encountered, the head is cut off with a wide and thin osteotome close to the acetabular rim. Since it is important to preserve as long a femoral neck as possible, care must be taken to determine the true junction of the head and neck before resection of the head is carried out.

Following the osteotomy, the extremity is everted, and the femoral head is removed from the acetabulum with a special Mathieu's hook and a Lambotte's spoon. Any residual spur formations on the upper surface of the neck are excised by means of a curved Putti's chisel. Any residual acetabular spurs are pried off with a sharp instrument, and the acetabular rim is smoothed with a file. The posterior capsule should be carefully inspected to make certain that no loose bodies or fragments, which may have been chipped off during the operation, are concealed.

When the case is one of nonunion without absorption of the neck, the head is simply removed from the acetabulum. Cases with absorption present some difficulty because of the short cervical stump. In order to permit abducting the extremity and at the same time to preserve the trochanteric mass, which constitutes the principal support for the prosthesis, the greater trochanter is chiseled through at its tip, and the fragment inclined outward, being left attached by the fascia at its base. This bony segment is smaller than that chiseled off in the Whitman's reconstruction operation. Only when the femoral neck is completely absorbed is the entire trochanter transplanted downward as in the Whitman operation.

In long standing congenital dislocation, the femoral head is pulled down until it lies opposite the acetabulum, and then the head is removed. Verbrugge has called attention to the possible necessity of resecting the smaller trochanter and freeing the psoas muscle in adult cases of congenital dislocation. This muscle through its power and direction opposes the lowering of the femoral extremity, and it practically occludes the border of the acetabulum, which must be re-formed.

Another suggestion was made by Verbrugge in treating cases in which the femoral head is

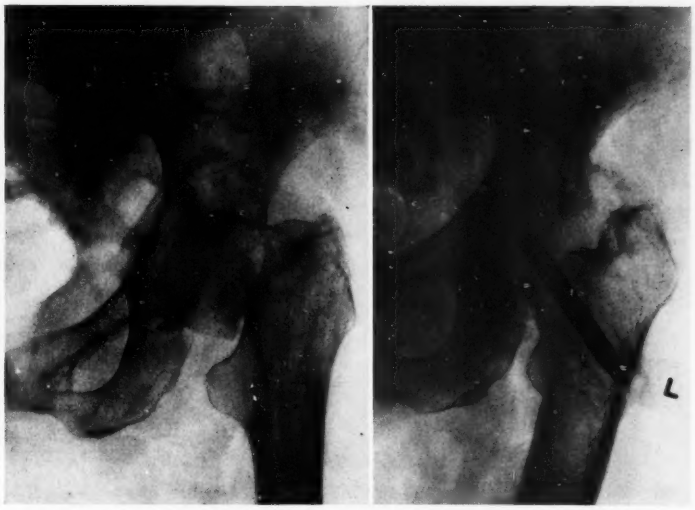

Fig. 19, left. Case 4. M.T.C. Fresh intracapsular fracture of the neck of the femur.
Fig. 20. Case 4. M.T.C. Roentgenogram taken 2 months after replacement of the femoral head by a prosthesis.

spread out over the neck, as in long standing Perthes' disease. In order to conserve the greatest possible part of the neck, only a small cap of the head should be removed.

Deepening of the acetabulum: The next step is to determine whether or not deepening of the acetabulum is indicated. This is an important step, for the cavity should be deep and smooth, and the prosthetic head when reduced should entirely disappear within it. Therefore, if the cavity is shallow, or its roof oblique, it is cleaned and hollowed out by means of a Judet reamer or a Hudson reamer (Fig. 6). The writer prefers the latter instrument. The reamer is similar in design to the plastic replacement for the femoral head, but its diameter is slightly larger. The prosthesis should be carefully selected as to size before the acetabulum is deepened with the reamer (see Description of prosthesis).

Insertion of the prosthesis: Good exposure of the sectioned neck is important. If motion at the hip joint is very restricted, it is well to mobilize the lower extremity, forcing it through various movements, in order to obtain better exposure of the cut surface.

A drill-hole is made through the middle of the femoral neck into which the tail of the prosthesis will be inserted (Fig. 7). The drill is 1 millimeter smaller in diameter than the stem of the prosthesis, a discrepancy in size that ensures a drive fit of the tail into the cervical canal. The drill should make its exit just below the greater trochanter, and pierce the cortex. The length of the tunnel, which is indicated on the drill, determines the length of the stem of the prosthesis to be used.

The neck is then shaped to fit the prosthesis by means of the special Judet shelf cutter (Figs. 8 and 9). All bony irregularities on the cervical stump are removed. The tail of the prosthesis is forced into the prepared tunnel, care being taken that it lies in the direction of slight valgus (Figs. 10, 11a and 11b). When the cap of the prosthesis is in position, a piece of gauze and a setter that fits the surface of the artificial head are, in turn, placed over it, and the prosthesis is hammered home with a mallet (Fig. 12). In the Judet technique, a great deal of stress is placed on the necessity of forcing the prosthesis into position. The new head should be driven into the femoral neck until the cap fits onto the shelf of the neck, and the tissues appear blanched from pressure. Methyl methacrylate is strong enough to withstand the forcible blows.

Fig. 21, left. Case 5. A.B. Roentgenogram showing aseptic necrosis of both femoral heads with coxa valga, secondary to bilateral congenital dislocation treated in childhood by open reduction.
Fig. 22. Case 5. A.B. Roentgenogram of the right hip taken 5 months after replacement of the femoral head.

Reduction and closure of the wound: The artificial head is easily reduced by gentle movements and by the use of traction on the extremity as required.

If the capsule has been preserved, it is sutured with chromic catgut. The muscles are allowed to fall back into place, and the fascia is sutured with chromic catgut. The skin is closed with interrupted sutures of silk.

A dressing is first applied, and then a tight 10 inch ace bandage is applied over the pelvis and down the thigh as far as the knee, to provide compression and prevent hematoma. The lower leg is bandaged from the toes up to the elastic spica to obviate swelling. No immobilization of the extremity in a plaster spica is required.

After-care: The patient lies in bed with the hips in 10 degrees of abduction and slight internal rotation. The position is easily maintained by the use of plaster boots with a bar between them. Penicillin is given until the temperature is normal.

Rest in bed in this position is maintained for 3 weeks. During this period, the head of the bed may be elevated to permit the patient to sit up, and the patient may lift himself with the aid of an overhead trapeze. After the third week, the patient may sit up in a wheel chair, and walk with the aid of crutches, but without bearing full weight on the involved extremity. After the fourth week, weight may be borne, and active mobilization of the hip by swinging exercises is begun. Roentgenograms are taken at the end of 4 weeks.

Important features of the Judet technique. The success of the operation as based upon the experience of the Judets and Verbrugge depends upon careful attention to certain technical details. These details as they were explained to the writer are as follows:

1. The exposure obtained without cutting muscle fibers or muscle attachments.

2. The preservation of as much of the femoral neck as possible, in order to reconstruct a joint that is mechanically sound.

3. Meticulous preparation of the cervical stump to receive the prosthesis, in order to ensure a solid and accurate fit of the artificial head.

4. Careful selection of the prosthesis as to size. It must fall easily into the acetabulum, being neither too small nor too large. The depth of its stem should be carefully determined by the length of the tunnel, as indicated on the drill, so that upon insertion,

Fig. 23, left. Case 6. E.B. Roentgenogram showing ununited fracture of the neck of the femur, 6 months after the injury.
Fig. 24. Case 6. E.B. Roentgenogram taken 2 months after replacement operation.

the tail will pierce the cortex of the femur just under the greater trochanter.

5. The diameter of the drill should be a shade smaller than that of the tail of the prosthesis, to ensure a tight fit.

6. The insertion of the prosthesis in proper position, that is, in slight valgus. The prosthesis should never be inserted in the varus position.

7. The hammering of the artificial head into position until the femoral neck appears white through the head.

Advantageous features of the Judet operation. The simplicity of the surgical technique is of great advantage. So logical are the operative steps that surprisingly little experience is required for one to become proficient in the execution of the technique.

The operation permits early treatment of lesions that are definitely progressive in character and that may result in total loss of function.

The operation in no way endangers life from the standpoint of producing shock. Since the majority of patients who suffer from chronic arthritic lesions and sustain fractures of the neck of the femur are elderly, an operation that may be practiced with minimum shock has a great advantage.

The elderly patient also benefits from the fact that prolonged immobilization of the extremity is not required.

Early mobilization is possible because no muscles are cut or disinserted at their attachments, and because the prosthesis is solid in position.

The freedom from pain after the operation is extraordinary, the joint being practically painless after the first or second day. The patient, much encouraged by this lack of pain, becomes confident and co-operates in mobilizing the joint.

Functional recuperation tends to be rapid as the result of early mobilization, but the rate of recovery is, of course, influenced by such factors as age, the condition of muscles and ligaments, and the temperament of the patient.

DESCRIPTION OF THE PROSTHESIS

The prosthesis is made of the plastic material called methyl methacrylate (Fig. 10). This is a transparent substance, which is light in weight, can be easily worked, and highly polished. In its solid form it is durable, and its resistance is about one-quarter that of soft steel. Both the thermal and electrical conductivity of this material is low.

Fig. 25, left. Case 7. N.P. Roentgenogram showing structural changes as the result of Perthes' disease in the right hip of a 14 year old boy.
Fig. 26. Case 7. N.P. Roentgenogram taken 1 month after replacement operation.

Experience with methyl methacrylate in plastic surgery has proved that it fulfills the requirements of good body tolerance. Organic liquids do not attack it. There is no reaction in the form of necrosis, sclerosis, or a secretion. The Judets, who have had occasion to intervene after the operation, have found scar tissue without a trace of reaction to the prosthesis. It is still too early to determine the body tolerance to a prosthesis of this type over a period of many years, but results after the lapse of approximately 4 years have been entirely satisfactory.

Methyl methacrylate has 2 features that may be considered drawbacks. The transparency of the material in roentgenograms is, possibly, a slight disadvantage. On the other hand, it is possible to observe clearly any structural changes in the bone at the attachment of the prosthesis.

The resistance of methyl methacrylate to heat presents a difficulty as to sterilization. In the Judet technique the prosthesis is sterilized in formic acid and boiled for 2 minutes. The manufacturers of methyl methacrylate, however, advise against boiling. The writer sterilizes the prosthesis by cleansing it with green soap and water and immersing it in a 1:1000 solution of zephiran over night.

In design, the prosthesis is cap shaped and mounted on a stem, which is reinforced with a steel core. The under surface of the cap is designed to fit onto the reshaped femoral neck. The prosthesis is made in 3 sizes, small, medium, and large, and each size is available with shafts of different lengths, short, medium, and long.

In the future, prostheses of different substances will, undoubtedly, be fabricated. Already, a prosthesis of nylon has been perfected, which surpasses methyl methacrylate in strength.

	Plexiglas (Methyl methacrylate)	Nylon
Specific gravity	1.18	1.14
Tensile strength	4000 P.S.I.	12175 P.S.I.
Impost strength (ft. lb. per inch of notch)	.2	.9

Nylon has been used for several years and has been found to cause no irritation in the tissues. It is thermolabile and the nylon prosthesis may be boiled along with surgical instruments.

REPORTS OF EXPERIENCES WITH THE JUDET OPERATION

In May of this year, Jean and Robert Judet reported their experience in 300 cases, extend-

ing over a period of approximately 4 years. In the great majority of cases, osteoarthritis was the indication for the operation; 20 cases were ununited fractures of the neck of the femur; and 2 cases were fresh fractures. Nontuberculous ankylosis and congenital dislocation of the hip of long standing were other indications.

Outstanding in the report of the results in the 300 cases is the statement that 80 per cent of the patients were able to return to work, some of them to heavy labor. Fifty per cent of the patients resumed light work from 2 to 3 months after the operation. In 7 of 10 cases, pain was absent or insignificant, and in the remaining cases, the pain was less severe and caused less handicap than before the operation. In 90 per cent of the cases, the range of motion was good or excellent, and one-third of the patients walked without a cane.

There were 3 deaths among the 300 cases. One occurred on the third day after the operation from an undetermined cause; 1 from uremia; and the third patient died of cerebral softening.

Verbrugge of Antwerp, next to the Judets, seems to have had the most experience with the operation. In 1949, he reported 30 cases of varying pathology in which the replacement technique was used, including chronic arthritis, nonunion of the femoral neck, fresh fractures of the neck, congenital dislocation of the hip, osteochondromatosis, and rhizomelia spondylosis with fusion of the hip in deformity. The results were so encouraging that Verbrugge has complete enthusiasm for the method.

Throughout the year 1949 and early in 1950, reports on the use of the Judet operation in small series of cases, or in an isolated case, appeared in French literature. At the time of the reports it was usually considered too early to judge the outcome, but all surgeons were encouraged by the immediate results. Sicard reported 12 cases, 11 of which were osteoarthritis, and 1, a nonunion. Padovani practiced the method in 10 cases of nonunion, and Poilleux, in 5 cases of nonunion. Other surgeons who have used the procedure are Guilleminet, Leclerc, Fayot and Baille, Brocq, and Enel.

Fig. 27. Roentgenogram showing osteoarthritis secondary to long standing Perthes' disease in a patient 30 years of age.

Three reports also appeared in Swiss literature. Perrot used the Judet method in 4 cases of coxarthritis; Naz, in a single case of nonunion; and Pruvot, in 1 case of nonunion and another of coxarthritis. All 3 surgeons considered the results encouraging.

PERSONAL EXPERIENCE WITH THE JUDET OPERATION

Thirty-one patients have been treated by this method since March 1950. In all cases the freedom from pain after the operation has been particularly striking. It is impossible to estimate the outcome in any of these patients treated so recently, but the immediate results are extremely favorable. Walking with the aid of crutches has been possible as early as 3 or 4 weeks after the operation. A good range of motion has been obtained. All hips have remained free from pain.

ILLUSTRATIVE CASES

CASE 1. E.M., a 63 year old female, had sustained a fracture of the neck of the right femur in September, 1948, which united perfectly following internal fixation by a Moreira bolt. Approximately 1 year later, the hip became sore, rotation was limited and painful, and the patient walked with a marked limp. As time went on, the pain and stiffness of the joint increased.

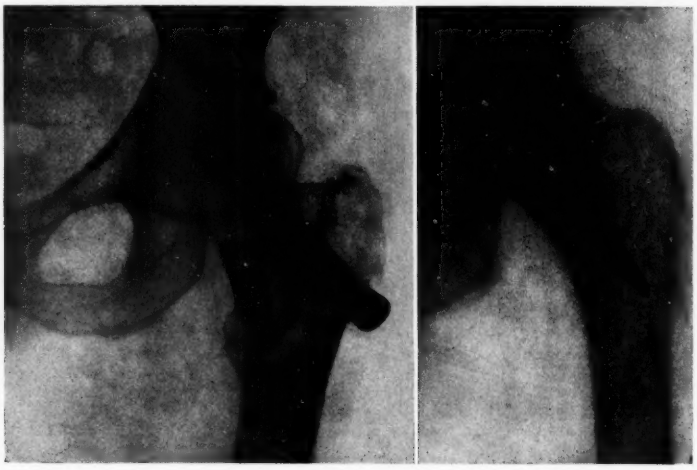

Fig. 28, left. Case 8. E.P. Roentgenogram showing osteoarthritis and atrophy of the femoral head 8 years after fracture of the neck of the femur, which had united satisfactorily.

Fig. 29. Case 8. E.P. Roentgenogram taken 2 weeks after replacement operation. The variation in bone structure is due to the previous internal fixation of the fracture.

Roentgenographic examination revealed avascular necrosis of the femoral head, absorption of the neck, and spur formations (Fig. 13).

On April 15, 1950, the replacement operation was carried out. Convalescence took place without pain.

Seven months after the operation, the patient was walking with a slight limp. Internal and external rotation was 50 per cent normal, flexion was possible to 110 degrees, and abduction to 10 degrees. The hip continued to be free from pain (Fig. 14).

Case 2. J.J., a male, 52 years of age, was first seen on September 15, 1948. He complained of pain in the right hip, which was increasing and radiating down the leg, and he walked with a marked limp. Ten years previously, the patient had dislocated this joint.

Upon examination, rotation at the hip joint was found to be extremely limited. Roentgenograms revealed a typical aseptic necrosis of the femoral head and arthritic changes (Fig. 15).

An arthrotomy to remove the spurs was first performed, and later a division of the internal obturator nerve to relieve pain. The alleviation of pain was only temporary, and rotation again became limited.

On May 16, 1950, the replacement operation was carried out. Six months after the operation, internal and external rotation was normal, flexion was possible to 120 degrees, and abduction and adduction were 50 per cent normal. No pain had been experienced. The patient was walking well, bearing full weight on the involved extremity (Fig. 16).

Case 3. G.B., a 57 year old male and a worker in a dye company, was first seen in March, 1950, when he complained of a limp, of pain in the left hip, which radiated down the leg, and of stiffness of the joint. In World War I, he had sustained an injury to the neck of the left femur from shrapnel, and in 1938 he had injured the same hip in a fall. On examination, motion in flexion was found to be limited to the right angle, and rotation was impossible. A roentgenogram revealed severe osteoarthritis of the hip joint and the presence of a foreign body (Fig. 17).

On April 5, 1950, the replacement operation was performed, and the foreign body removed. The patient had no pain throughout convalescence.

Seven months after the operation, the hip joint had normal motion in rotation, motion in flexion to within 10 degrees of normal, and good power of abduction. The patient had been working for 4 months. No pain had been experienced. Roentgenogram (Fig. 18) was taken 6 weeks after the operation.

Case 4. M.T.C., a female, aged 73 years, had sustained a fracture of the right hip in 1947, which was treated first by nailing without success, and later by a reconstruction operation, which also failed. The fracture remained ununited and an arthritic process developed. For 3 years, the patient suffered considerable pain and was markedly disabled.

On May 27, 1950, the patient suffered a fracture of the neck of the left femur (Fig. 19). In view of the result of the fracture on the right side, a prosthetic operation was immediately carried out on the left hip.

Five months after the operation, motions at the hip joint were free. The patient had experienced no pain since the operation. She walked with the aid of a cane, bearing full weight on the left leg (Fig. 20).

Case 5. A.B., a 30 year old female, had been treated by the writer 27 years previously for congen-

ital dislocation of both hips, which had been successfully reduced by open reduction. For many years afterward she led a normal life. At about the age of 25, the hips began to be painful, and the patient had difficulty putting on her shoes.

When she was seen in September, 1949, she walked with an extreme wobble, the knees scraping by each other. On examination, abduction of the hips was found to be impossible, and rotation was markedly limited. A roentgenographic examination showed aseptic necrosis of both femoral heads and marked coxa valga with the greater trochanters riding high (Fig. 21).

Treatment consisted of, first, transplanting the greater trochanters of both hips downward on the femoral shafts. On May 29, 1950, the replacement operation was carried out on the right hip. The screw used in reimplanting the greater trochanter in the previous operation was removed.

Five months after the operation, when the patient was last examined, all motions were free at the hip joint and carried out without spasm. Flexion was possible to 120 degrees, abduction to 15 degrees, and adduction to 10 degrees. The patient had had no pain. She was walking and bearing weight on the involved extremity.

CASE 6. E.B., a female, aged 65 years, had sustained a fracture of the neck of the left femur, which resulted in nonunion (Fig. 23). Six months after the fracture, the patient sought relief from pain and a limp.

On August 25, 1950, the replacement operation was performed. Ten weeks after the operation, internal and external rotation was normal, flexion was possible to 120 degrees, abduction to 15 degrees, and adduction to 10 degrees. The patient was walking with the aid of crutches (Fig. 24).

CASE 7. N.P., a 14 year old boy, had been treated at various clinics over a period of years for Perthes' disease of the right hip. When the patient was first seen in August, 1950, he was still having pain, and he walked with a limp. Roentgenographic examination showed the structural changes resulting from the lesion (Fig. 25.)

This is the type of case in which the limp, the restriction of motion, and pain continue to increase with the years as osteoarthritis develops secondary to the deranged mechanics of the joint. Figure 27 shows the appearance of a hip joint in a patient 30 years of age, who had suffered from Perthes' disease.

On August 29, 1950, the Judet replacement operation was carried out.

Two months after the operation, the hip had motion in flexion to 90 degrees and normal rotation; abduction and adduction were 50 per cent normal. The patient had had no pain. He walked without the aid of crutches (Fig. 26).

CASE 8. E.P., a 56 year old school teacher, had sustained a fracture of the neck of the left femur in 1942, which was successfully treated by internal fixation. Five years later, the hip began to be painful and stiff, with pain radiating down the leg. The patient was considerably handicapped in her work as the principal of a school.

On examination, internal rotation was found to be possible to only a slight degree, and external rotation was entirely absent. Roentgenographic examination showed osteoarthritis of the joint and atrophy of the femoral head (Fig. 28).

On August 18, 1950, the Judet replacement operation was carried out. The nail used in treating the fracture was removed. The patient had no pain after the operation.

Seven months later, rotation was normal, and flexion of 45 degrees and abduction of 10 degrees were possible. No pain had been experienced. The patient was bearing full weight on the involved extremity (Fig. 29).

CONCLUSIONS

It is obvious that more time is required and further experience needed before the Judet method can be finally evaluated. With all their experience, the Judets emphasize continually that the future of this procedure is not yet known. What is certain is that after nearly 4 years of experience, the results are extraordinarily gratifying. In all cases reported, the prosthetic replacement of methyl methacrylate has proved to be durable, well tolerated by the body tissues, and there has been no loosening of the prosthesis at the seat of fixation.

The operation has proved itself in the large field of osteoarthritic hips in which it has been most extensively practiced. In ununited fractures of the neck of the femur, the results have been extremely satisfactory. In many other chronic lesions of the adult hip of varying pathology, as well as in fresh fractures of the neck of the femur, the results have been most gratifying.

The relief from pain in a day or two after the operation and the continued absence of pain are striking. In fact, because of the great relief from pain, patients with bilateral lesions have requested early operation on the other hip. Two patients in the writer's experience have made such requests. A stable, functional joint is obtained, and the patient walks well. The value of this method may, however, be estimated in more than relief from pain, limping, and stiffness of the joint, for by this

method the functional capacity may be restored to the extent that a person is able to resume the normal activities of life and return to work.

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CARCINOMA OF THE RECTUM

Prognosis Based on the Distance of Lesions from, or Involvement of, the Levator Ani Muscle, and Involvement of the Anal Sphincters

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THE surgical treatment of carcinoma of the rectum and rectosigmoid areas of the large intestine is one of the controversial subjects in the current surgical literature (18). The controversy resolves itself into the question of whether operative procedures designed to preserve sphincteral function are sufficiently radical to be as curative as the classic combined abdominoperineal resection for carcinoma in these areas. Accordingly, in the past few years the surgical literature has contained much evidence pro and con in the form of investigative work and reports of various surgical procedures employed in the treatment of this condition.

From data available in the literature it appears evident that in lesions of the lower part of the sigmoid, rectosigmoid, and rectum removed by the Miles operation the prognosis is less favorable in the low-lying than in high-lying lesions (3, 14, 15, 27). In considering the efficacy of any surgical procedure used in the treatment of cancer of these areas it would seem of value to study the possible factors responsible for the poorer prognosis noted in these low-lying lesions removed by the combined abdominoperineal operation. Factors to be considered in comparing lesions at different levels in the colon are the type (Dukes, 10), grade (Broders), venous invasion, local extension, and lymphatic spread. Evidence available tends to point to lymphatic spread and venous spread as the two most important factors in the difference of curability noted in high-lying and low-lying lesions.

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It is obvious that once the venous system has been involved by the cancer even the most radical surgical treatment will be of limited value. However, if the spread of the cancer is limited to the lymphatic system, the cure rate will be greatly influenced by the degree of radicality of the surgical treatment employed. Of the three zones of lymphatic spread described by Miles, the lateral zone has been considered by most investigators as the route of spread responsible for the poorer prognosis in low-lying cancers of the colon. Investigations concerning the lateral avenue of spread over the levator ani muscle and its accompanying structures have been relatively meager and are somewhat inconclusive. Actually, only relatively few cases have been reported in which spread along these channels has been found.

It is because of this relatively meager evidence for lateral spread of carcinoma along the levator ani muscle that this study was undertaken. It was hoped that by a study of the relationship of the proximity of the carcinoma to the levator ani and by a search for spread over this muscle and its accompanying structures more evidence regarding the role of the levator ani in the prognosis of carcinoma in the lower part of the colon and the rectum could be established.

In considering surgical procedures designed to preserve anal function, in which the external and internal sphincters are saved, it would seem desirable to study the effects on the prognosis of the proximity of the lesion to these structures. An attempt has been made in this study to establish the frequency of involvement of these anal sphincters and to determine what effect the spread of the cancer to the sphincters has on the prognosis. As very little information regarding this aspect

of the surgical treatment of lesions of the lower part of the rectum can be found in the literature it is hoped that this study may be of some value.

REVIEW OF LITERATURE

The literature contains many excellent descriptions of the three methods of spread of carcinoma from the lower part of the colon and the rectum. These methods of spread are by direct extension from its site of origin, by invasion of the venous system or by the lymphatic channels which drain the site of the lesion. Miles's description of the spread of carcinoma by the lymphatics, based on the work of Delamere, Poirier, and Cunéo and on his own observations of surgical and necropsy cases, is one of the major contributions in the field of colonic surgery. Of the three zones of lymphatic spread described by Miles, the lateral zone concerns this study more. It refers to spread over the middle hemorrhoidal channel of lymphatics along the levator ani and does not mean spread by direct extension through the bowel wall over the adjacent structures. Far fewer studies have been done on the spread of carcinoma over this avenue of extension than over either the superior or the inferior pathways, and the results from those observations are relatively inconclusive. In Miles's opinion the spread along the lateral route is the least important of the three modes of spread. He expressed the belief, however, that the levator ani is especially vulnerable to lymphatic spread and stated that he had found metastasis near the attachment of the levator ani to the rectal wall, near the pelvic wall, and in the substance of the levator ani. He referred to a case in which plaques of malignant cells were found in the substance of the levator ani and in the lymphatic plexus above it. He did not mention the exact number of cases in which this lateral spread was found.

Gilchrist and David (13) stated that 4 of 27 surgical specimens studied showed lateral nodal involvement along the superior surface of the levator ani muscle. In 1 case, in which the lesions lay at the level of the levator ani, two involved nodes were found situated 2.5 centimeters laterally to the muscularis of the bowel and one involved node was found along the superior lymphatic drainage path. The second case also showed an involved node 4 centimeters below the lesion in addition to lateral spread. In the other 2 cases there were positive nodes about 1.5 centimeters below the lesion, which may have been secondary to extended intramural spread. Gilchrist and David (13) concluded from these findings that there is a double lymphatic drainage if the lesion lies at the level of the levator ani muscle: the usual spread is upward along the superior hemorrhoidal vessels, more rarely along the superior surface of the levator. Also, in a necropsy study of a case in which the patient had died shortly after combined abdominoperineal resection, they found a single involved node left behind situated about 1 centimeter lateral to the point of severance of the levator ani.

Coller, Kay, and MacIntyre reported, in 1 of their necropsy cases with the lesion at the anal margin, that seven nodes were involved all of which were along the course of the middle hemorrhoidal artery. This seems to be good evidence of lateral lymphatic spread in a case in which the superior route of spread was not blocked. In 7 of 19 cases of very low-lying rectal cancers there was evidence of nodal involvement up to the margin of the excision of the levator ani muscle. In 6 of these cases there were also involved nodes along the superior route of spread. In none of the lesions in which the inferior border was 2.5 centimeters or more above the mucocutaneous junction (5 cm. above the anal margin) were metastatic growths along the lateral zone of spread found.

Dukes (11) also stated that lesions in the midrectum had a poorer prognosis than the higher or lower lesions because of the tendency of the ampullary lesions to spread laterally along the lymphatics accompanying the middle hemorrhoidal vessels. In a study of 100 specimens, Gordon-Watson and Dukes found evidence of lateral spread along the surface of the levator ani in only 1 case. Gordon-Watson stated that in advanced cases, beyond the reach of surgical cure, when the superior hemorrhoidal and inferior mesenteric nodes are obstructed by extensive me-

tastasis, carcinoma cells may be found in the middle hemorrhoidal region, and when this happens the iliac lymph nodes ultimately become involved. In growths low down in the rectum, when the upward path is obstructed by extensive metastasis, downward spread into the ischiorectal fossa has very occasionally been met with, which may spread along the inferior hemorrhoidal artery to the inguinal lymph nodes. Save in these advanced and exceptional cases, a lateral or downward lymphatic spread is so rare as to be negligible.

Gabriel, Dukes, and Bussey found no evidence of lateral spread unless the nodes along the upper zone of spread were completely blocked by metastases.

Grinnell found only 1 case of lateral spread, and this was in a lesion 6 centimeters above the pectinate line and showed spread in all three zones. The upward zone was blocked by extensive metastasis.

Dafoe, in a study of 100 specimens of advanced lesions lying within 4.5 centimeters of the pectinate line, found 1 case with involvement of the levator ani muscle. This was a case in which the intestinal wall was perforated, and the spread was apparently by direct extension and not by lateral spread over the lymphatics.

Wood and Wilkie made numerous sections of the levator ani and the external anal sphincters but found no examples of secondaries along these structures.

Thus, there is evidence that lateral spread along the levator ani and its fascia and lymphatics does occur, especially in lesions in which the upper lymphatic channels are blocked by metastasis. Actually, however, there are relatively few cases reported. As this mode of spread along with venous spread is incriminated in the much poorer prognosis of the lesions in the lower part of the rectum, and as anatomically, the potentiality for lymphatic spread is good, it would appear that metastasis over this route with secondaries in the levator ani and its accompanying fascia and lymphatics would be more commonly observed. It was in an attempt to find more evidence of lateral spread of carcinoma of the rectum along the levator ani muscle that this study was undertaken.

MATERIALS AND METHODS

Two hundred and ninety-three surgical specimens of adenocarcinoma of the rectum, rectosigmoid, and lower part of the sigmoid removed by combined abdominoperineal resection were obtained from the Division of Surgical Pathology of the Mayo Clinic for this study. Twenty-one cases were excluded from this group for one of the following reasons: insufficient clinical data, immediate postoperative death, lack of information as to the preoperative level of the lesion, no record of the measurements of the level of the lesion in the fresh surgical specimen, and destruction of the preserved surgical specimen sufficient to preclude reasonably accurate study and measurements. There was no selection of cases as to grade (Broders) or type (Dukes) of the tumor. Two hundred and seventy-two remained for study.

These 272 cases were then studied carefully regarding their clinical history, preoperative measurements of the level of the lesions, the report of the pathologist, the measurements of the level of the lesion in the fresh surgical specimen, and the 5 year survival. The formalin-preserved surgical specimens of these 272, removed by the combined abdominoperineal operation, were then carefully studied. Measurements were taken of the size of the lesion, the distance from the lower border of the lesion to the dentate margin, and the distance from the lower border of the lesion to the point of insertion of the upper surface of the levator ani muscle into the rectal wall. Also the distance from the upper surface of the levator ani muscle to the dentate line was measured.

To confirm the pathologist's report of the fresh specimen, blocks of the tumor in the preserved specimen were obtained and the microscopic grade (Broders) was checked. In those specimens in which no nodal involvement had been found in the fresh specimen, the nodes were rechecked grossly, and several, at least 2, from each specimen, were removed and saved for microscopic confirmation.

The foregoing blocks of tissue and lymph nodes were then sectioned to 10 microns by means of the freezing microtome and were stained with hematoxylin and eosin in the

TABLE I.—DISTRIBUTION OF GRADE AND TYPE ACCORDING TO THE LEVEL OF THE LESION ABOVE THE LEVATOR ANI

Distance above levator, cm.	Grade			Type		
	Grade	Number	Per cent	Type	Number	Per cent
0–2	1	32	44.4	A	12	16.7
	2	31	43.1	B	26	36.1
	3	3	4.2	C	34	47.2
	4	6	8.3			
	Total	72	100.0		72	100.0
2.5–6	1	43	35.8	A	27	22.5
	2	59	49.2	B	28	23.3
	3	12	10.0	C	65	54.2
	4	6	5.0			
	Total	120	100.0		120	100.0
6.5–15	1	15	18.8	A	14	17.5
	2	57	71.2	B	27	33.7
	3	7	8.8	C	39	48.8
	4	1	1.2			
	Total	80	100.0		80	100.0

routine manner. These sections were then carefully studied microscopically for carcinomatous involvement. This information was then tabulated and the cases were grouped according to the level of the lower border of the lesion above the insertion of the superior surface of the levator ani into the rectal wall. The distribution of the grade and type according to the level of the lesion is shown in Table I. The 5 year survival rates were then calculated for the lesions in the three groups according to the level of the tumor above the levator (Table II).

To study the incidence of spread of carcinoma along the levator ani muscles and the accompanying structures, 210 of the foregoing preserved surgical specimens were carefully studied grossly and microscopically. Suspicious regions were sectioned, and blocks of tissue were removed, placed in small bottles containing 10 per cent formalin and saved for further microscopic study. In those cases in which no suspicious regions of involvement could be found grossly, at least two blocks of tissue containing the levator ani as it inserted into the rectal wall were obtained. These blocks included the internal sphincter, external sphincter, and adjacent perianal skin in cases in which any evidence of involvement was noted. They were then carefully studied microscopically for carcinomatous involvement, and the results were recorded. Table III shows the distribution of these 210 cases according to the level of the lesion, grade (Broders), and type (Dukes).

RESULTS

The results of this study as to the effect of the proximity of the lesion to the levator ani muscle on prognosis are shown in Table II. From a study of these 5 year survival rates it may be concluded that the prognosis of adenocarcinoma of the rectum and sigmoid colon treated by combined abdominoperineal resection decreases the nearer the lesion is situated to the levator ani muscle and this is most markedly noted in lesions with nodal involvement.

When comparing these 5 year survival rates with those reported by other investigators using the dentate margin as the point of reference, it is important to consider the distance between this landmark and the upper surface of the levator, the point of reference in this investigation. The average distance between these two points was found to be 0.83 centimeter, as was determined by averaging the measurements made on the 210 specimens used in this study. Other distances to be considered in comparing various series are the length of the anal canal, which is generally considered to be 2 centimeters, and the shrinkage of the specimen occurring during preservation in formalin, which was determined in this study and will be described later.

During the course of this study considerable discrepancy was noted between measurements taken of the fresh surgical specimen and those taken on the formalin-preserved specimen. It was of some interest to determine the average amount of shrinkage which occurred in these specimens. This was done by a comparison of measurements made before and after preservation. The difference in the distance from the dentate margin to the lower border of the lesion in the fresh and in the preserved specimen was determined. As the amount of

shrinkage is in proportion to the linear amount of tissue involved, the average shrinkage was calculated and recorded in three groups. In those specimens with 0 to 5 centimeters of tissue between the dentate margin and the lesion as measured in the fresh specimen, the average amount of shrinkage was found to be 0.31 centimeter. In those specimens with 5.5 to 10 centimeters of tissue between these two points the average shrinkage was 1.28 centimeters. In the third group with 10.5 to 15 centimeters of tissue between the dentate margin and the lesion an average of 2.73 centimeters shrinkage was noted in the formalin-preserved specimen.

Careful gross and microscopic study of these 210 surgical specimens of carcinoma of the rectum, rectosigmoid, and lower part of the sigmoid removed by the combined abdominoperineal resection failed to reveal any evidence of lateral spread of the carcinoma along the levator ani muscle or its accompanying fascia and lymphatics. There were 133 cases in which the lesion was 6 centimeters or less above the level of the insertion of the superior surface of the levator into the rectal wall. Forty-two of these lesions were 2 centimeters or less above the levator ani and 16 were at the level of the insertion of the levator. In the remaining 77 cases the lesion was 6 centimeters or more above the levator. In 1 case in which the lesion was at the level of the insertion of the levator, the carcinoma had extended through the rectal wall to within approximately 1 millimeter from the insertion of this muscle. This case represents the best evidence for involvement of the levator that could be found in this study. Thus, this investigation failed to reveal any instance of lateral spread of carcinoma of the rectum along the levator ani muscle either by direct extension or by lymphatic channels.

Incident to the main problem of searching for carcinomatous involvement of the levator ani and its accompanying structures, an attempt was made to study the frequency of involvement of the sphincter muscles of the rectum. Careful gross examination and microscopic study of the external sphincters in regions where carcinomatous involvement was suspected and in regions nearest to the tumor

TABLE II.—FIVE YEAR SURVIVAL RATES OF PATIENTS HAVING ADENOCARCINOMA OF THE RECTUM AND SIGMOID COLON TREATED BY COMBINED ABDOMINOPERINEAL RESECTION

Level of lesion above levator ani, cm.	Nodal metastasis	Patients		Lived 5 or more years	
		Total	Traced	Number	Survival rate, per cent*
0–2	All cases	72	62	33	53.3
	Without	38	30	23	76.7
	With	34	32	10	31.2
2.5–6	All cases	120	115	66	57.4
	Without	55	51	43	84.3
	With	65	64	23	35.9
6.5–15	All cases	80	78	49	62.8
	Without	41	40	34	85.0
	With	39	38	15	39.5
	Total	272	255	148	58.0

*Per cent of traced patients. Inquiry as of January 1, 1950.

failed to reveal any evidence of carcinomatous invasion of either the deep or superficial external sphincters.

In 18 of the 210 specimens studied invasion of the internal sphincter was found. Involvement of this muscle with carcinoma was found in 17 cases (40.5 per cent) of the 42 cases in which the lesions were 2 centimeters or less above the levator ani. In 12 cases the lesions were located at the level of the levator ani muscle. In 5 other cases none of the lesions were higher than 2 centimeters above the insertion of the levator ani or approximately 5 centimeters above the anal margin. These cases all represented intramural extension along the intestinal wall. In 1 additional case the lesion was located 5 centimeters above the levator (7.8 cm. above the anal margin). This was considered a case of retrograde lymphatic spread. The 5 year survival rates of patients with carcinomatous involvement of the internal sphincters were compared with the rates of patients with lesions at comparable levels but without involvement of the internal sphincters. All patients in the two groups had lesions 2 centimeters or less above the levator ani. Although the number of cases is small, there appears to be a definitely poorer prognosis in patients with involvement of the in-

TABLE III.—DISTRIBUTION OF GRADE AND TYPE ACCORDING TO THE LEVEL OF THE LESION ABOVE THE LEVATOR ANI

Distance above levator, cm.	Grade			Type		
	Grade	Number	Per cent	Type	Number	Per cent
0–2	1	16	38.1	A	2	4.8
	2	21	50.0	B	12	28.6
	3	1	2.4	C	28	66.6
	4	4	9.5			
	Total	42	100.0		42	100.0
2.5–6	1	29	31.9	A	18	19.8
	2	47	51.6	B	15	16.5
	3	10	11.0	C	58	63.7
	4	5	5.5			
	Total	91	100.0		91	100.0
6.5–15	1	15	19.5	A	14	18.2
	2	54	70.1	B	25	32.5
	3	7	9.1	C	38	49.3
	4	1	1.3			
	Total	77	100.0		77	100.0

ternal sphincter muscle than in those without involvement, as seems apparent from Table IV.

The clinical records of the foregoing patients were studied in an attempt to determine preoperatively in which cases of adenocarcinoma of the lower part of the rectum there is invasion of the internal sphincters with cancer. A study of the presenting symptoms revealed no significant difference in the two groups of patients. However, a significant difference was noted in the duration of symptoms before the patient came to treatment. Of the 25 cases in which no involvement of the internal sphincters was found the average duration of symptoms before the patient came for treatment was 11.6 months. Of the 18 patients in whom the internal sphincter was invaded by carcinoma the average duration of symptoms before coming to treatment was 9.0 months.

Thus, the only feature of low-lying carcinomas of the rectum with involvement of the internal sphincters which may serve to differentiate them from lesions without sphincteral involvement is the duration of symptoms. Patients with sphincteral invasion apparently, according to this study, come for treatment sooner than those in whom the sphincter has not yet become involved with the tumor.

COMMENT

The importance of the level of the lesion in the prognosis of carcinoma of the colon has been pointed out by others (14, 27). The 5 year survival rates of patients with lesions of the lower part of the sigmoid and the rectum treated by combined abdominoperineal resection are shown in Table II and indicate that the prognosis becomes poorer the lower the lesion is situated in the colon. As data presented by Waugh and Kirklin were based on the level of the lesion above the anal margin and data presented here were determined by using the distance of the lesion above the levator ani, it is necessary to add a certain correction factor for comparison. Thus, 2 centimeters, the length of the anal canal, and 0.83 centimeter, the distance of the levator ani above the dentate line, must be added to the level of the lesion in this study, for comparison. For comparing the data presented here with the data determined from fresh surgical specimens as in the work of Gilchrist and David (14), a further factor, the shrinkage factor, should be considered. This factor may be estimated from the linear amount of tissue in the fresh specimen between the lesion and the dentate margin. As mentioned previously, the average shrinkage determined for tissue up to 5 centimeters in length is 0.31 centimeter, for 5.5 to 10 centimeters the average shrinkage is 1.28 centimeters, and for the tissue measuring 10 to 15 centimeters in length the shrinkage factor is 2.73 centimeters.

Variations in the length of the rectum, the level of the pelvic peritoneal fold, change in the length of the rectum after mobilization, difference in the interpretation of descriptive terms, and the inaccuracy of measurement made by proctoscopic examination add considerably to the difficulty in the study and evaluation of treatment of these lesions. The insertion of the upper border of the levator ani muscle was used as the point from which the level of the lesion was determined in an attempt to give a more accurate and possibly more useful reference point for the surgeon in his final decision regarding the surgical

procedure to be employed in the treatment of low-lying lesions of the colon. Also, as the levator ani and its accompanying fascia and lymphatics apparently play a most important role in the spread of carcinoma in these regions, it was felt that a study of the relationship of the proximity of the cancer to this structure may be of value.

It is agreed by most authors that measurements in such surgical specimens, whether preserved, fresh or even in their normal position in the body, are somewhat inaccurate because of stretching and distortion. It is felt, however, that measurements taken on preserved specimens are relatively as accurate as those taken on fresh specimens and possibly more accurate for investigations of this nature.

The tables presented here show a drop in the 5 year survival rate as the lesion approaches the insertion of the levator ani. The poorest prognosis is noted to occur in those lesions within 2 centimeters of the levator ani (approximately 5 cm. above the anal margin), in which there is a 31.2 per cent 5 year survival rate in those lesions with involved nodes and 76.7 per cent survival rate in the lesions without involvement of lymph nodes. A more favorable prognosis is noted in lesions between 2.5 and 6 centimeters (5 to 10 cm. above the anal margin) where the survival rate in lesions with involved nodes is 35.9 per cent and in those without involved nodes is 84.3 per cent. Although these rates are slightly higher than those reported by Waugh and Kirklin, they are within the range of statistical error for a series of this size.

In considering the factors which may play a part in the poorer prognosis seen in low-lying cancers of the colon, it is not likely that the grade (Broders) is the responsible factor. This study, as does others, shows only a slightly higher frequency of grade 3 and 4 lesions as the level of the tumor approaches the lower part of the rectum (Table I). In addition, Waugh and Kirklin in a study of the influence of the level of the lesion on the prognosis of cancer in these areas found a similar drop in survival rates when considering only grade 2 lesions.

Likewise, it is not probable that the type (Dukes) is the responsible factor in the poorer prognosis of these low-lying tumors. This study and others reveal a higher per cent of type C lesions as the level of the tumor approaches the lower part of the rectum (Table I). However, this does not appear to explain the less favorable outlook, since when only type C lesions are considered the survival rates are found to decrease also.

TABLE IV.—FIVE YEAR SURVIVAL RATES OF PATIENTS WITH ADENOCARCINOMAS 2 CENTIMETERS OR LESS ABOVE THE LEVATOR

Nodal metastasis	Traced patients	Lived 5 or more years	
		Number	Survival rate, per cent*
Without involvement of the internal sphincters			
All cases	25	11	44.0
Without	9	6	66.7
With	16	5	31.2
With involvement of the internal sphincters			
All cases	17	6	35.3
Without	5	3	60.0
With	12	3	25.0

*Per cent of traced patients. Inquiry as of January 1, 1950.

Evidence of increased frequency of venous involvement by carcinoma in low-lying lesions of the colon has been reported by Sunderland. He stated that venous invasion was seen most frequently in cancers of the lowest 6 centimeters of the colon and the prognosis of these low-lying lesions was correspondingly worse. It must be concluded therefore that the increased frequency of venous invasion seen in cancer of the lower part of the colon is an important factor in the less favorable prognosis associated with these lesions. It is apparent that more radical surgical procedures will not control spread by this route and that early surgical removal of the carcinoma before the veins have become involved is mandatory.

The peritoneal reflection is widely used as a dividing line for treatment and for studying results of treatment of carcinoma of the lower part of the colon. It has been shown that the relation of growths to this reflection per se does not have any effect on prognosis (20). However, the importance of the regional anatomy below this point must be considered. In that portion of the bowel below the peritoneal

reflection, the fascial and muscular attachments, as well as contiguity to the neighboring structures and the varying pathways of lymphatic spread, make complete eradication of cancer less certain than in high-lying tumors of the rectum (14).

The remaining factor, lymphatic spread, has been considered, by the majority of authors, the most important factor in the poorer prognosis of the low-lying lesions. Of the three avenues of lymphatic spread, the inferior zone is rarely found involved. If the superior zone were the responsible route of spread, the results obtained from the combined abdominoperineal resection procedure would be poorer for the higher than for the lower lesions. Thus, it is generally agreed that the lateral zone over the levator ani muscle is the lymphatic avenue of spread responsible for the less favorable prognosis noted in low-lying lesions of the colon.

The role of the levator ani in prognosis. The assumption that lateral spread of carcinoma over the levator ani and its accompanying structures is responsible for the less favorable prognosis in lesions of the lower part of the colon is based on anatomic studies revealing potential avenues of spread over this muscle, on studies such as this showing a poorer prognosis as the lesion approaches these structures, and on a relatively few cases reported in which actual spread has been found over this route. This investigation, although adding presumptive evidence for lateral spread over the levator ani, failed to reveal any instance of actual carcinomatous spread over this muscle, its fascia or lymphatics. In only 1 case the intestinal wall was involved with carcinoma up to within approximately 1 millimeter of the insertion of the levator and this was direct extension through the intestinal wall. Other investigators have reported actual evidence of lateral spread, but the number of cases is relatively small. The largest number of cases in which there was actual spread over the lateral route have been reported by investigators using the clearing technique for finding metastasis. Gilchrist and David (13) found 4 of 47 surgical specimens with lateral spread. Coller, Kay, and MacIntyre found 6 of 53 surgical specimens with spread along the lateral zone. Other investigators were unable to find much evidence of lateral spread, although they all believe it occurs. Gordon-Watson and Dukes found metastasis along the levator ani in only 1 case of 100 specimens studied. Wood and Wilkie found no examples of spread in a similar study. Dafoe in a study of 100 cases of far-advanced carcinoma found only 1 case in which the perforation of the intestinal wall had occurred and the levator ani was involved by direct extension.

If the assumption that the poorer prognosis of low-lying lesions is due to lateral spread along the levator ani and its fascia is correct, an explanation for the relative paucity of reported cases in which this has occurred is certainly to be desired. Probably the most likely explanation lies in the reasoning that the tissues to which this spread occurs are not completely removed during the course of the combined abdominoperineal resection and thus, in studies such as this, enough of the levator ani and fascia to include the regions of spread is not present in the surgical specimen. It is probable that more complete studies of the tissues in the lateral zone up to the pelvic wall, such as may be obtained at necropsy, would be of great value in establishing more accurately the frequency of lateral spread over the levator ani.

Involvement of the anal sphincters. The effect on prognosis of involvement of the anal sphincters would appear to be of some significance in the surgical treatment of carcinoma of the lower part of the rectum, especially in regard to those procedures, such as the various modifications of the pull-through operation, in which preservation of the sphincteric mechanism is a feature (1, 2, 4, 9, 21, 23, 24, 26). No invasion of the external sphincter by direct extension or by lymphatic spread was found in this investigation. Wood and Wilkie in a similar study were unable to find involvement of the external sphincter. It would appear, therefore, that preservation of this muscle is not contraindicated in lesions of the lower part of the colon.

However, from results obtained in this study, the advisability of preserving the internal sphincter in lesions 5 centimeters or less above the anal margin (2 cm. or less above the

levator) is questionable. In the 42 cases studied in which the lesion was 5 centimeters or less above the anal margin, 17 (40.5 per cent) had involvement of the internal sphincter. In 1 additional case in which the lesion was situated 7.8 centimeters above the anal margin invasion of the internal sphincter was found. Complete blockage of the upper lymphatic channels was present in this specimen, and it was considered that retrograde lymphatic spread had occurred. Thus, in all cases but 1 in which the internal sphincter was involved, the lesions were situated 2 centimeters or less above the levator (5 cm. or less above the anal margin). Because of the difficulty encountered in determining exactly where the upper border of the internal sphincter ended and where the ordinary circular muscle of the bowel began, only cases were included, in the group showing involvement of the sphincter, in which there was no doubt that the muscle involved was the internal sphincter. It is probable therefore, that the 2 centimeter level above the levator, which seemed to be the boundary of such lesions in this study, might actually be too low.

The effect of involvement of the internal sphincter on prognosis is shown in a comparison of the 5 year survival rates in lesions at a comparable level with and without involvement of the sphincter (Table IV). Although the number of cases is not great, the trend seems to be definite. Thus, a drop in the over-all survival rates from 44.0 per cent in cases without involvement of the internal sphincter to 35.3 per cent in cases with invasion of this muscle, is seen. In the group without nodal metastasis the 5 year survival rate drops from 66.7 per cent in the group without invasion of the sphincter to 60 per cent in the group with invasion of this muscle. In the group with nodal metastasis these rates decrease from 31.2 per cent in cases without sphincteral involvement to 25 per cent if the lesion has spread to the sphincter. It should be mentioned in connection with the foregoing survival rates that the average level of lesions in which no involvement of the sphincter was found was 0.95 centimeter higher than the average level of lesions in which the sphincter was invaded.

The presenting symptoms of the patients with lesions 2 centimeters or less above the levator were studied and tabulated in an attempt to establish whether invasion of the internal sphincter could be determined preoperatively. It might be expected that if the sphincter were involved symptoms of some degree of incontinence, urgency, or tenesmus would be noted. However, in comparing the presenting symptoms of these two groups of patients, no significant difference in the character of symptoms was found in this study. It was noted, however, that the average duration of symptoms in patients in whom the lesion had invaded the sphincter was 9.0 months, as compared to 11.6 months in patients in whom the sphincter was not involved with the carcinoma.

It may be concluded, therefore, that procedures in which the internal sphincter is preserved should not be employed for lesions at approximately 5 centimeters or less above the anal margin. This conclusion is based on the results of this investigation in which it was found that approximately 40 per cent of these lesions will have involvement of the internal sphincter muscle and with such involvement present, the prognosis is significantly lowered. Likewise, aside from the tendency of patients in whom the cancer has invaded the internal sphincter to come for treatment earlier than those in whom the internal sphincter is not involved, spread to this structure cannot be determined on the basis of the presenting symptoms.

SUMMARY AND CONCLUSIONS

In a study of the 5 year survival rates of 255 traced patients who had carcinoma of the lower part of the sigmoid, rectosigmoid and rectum removed by combined abdominoperineal resection, it is shown that the prognosis decreases the nearer the lesion is situated to the levator ani muscle.

Although it is assumed by most investigators that the poorer prognosis of these low-lying lesions is due to the extension of the carcinoma along the lateral zone of spread over the levator ani, no instance of such spread was found in this study of 210 surgical specimens removed by the combined abdominope-

rineal operation. It is probable that necropsy study in which all the tissue in the lateral zone of spread to the pelvic wall is available would be necessary for a complete and accurate investigation of this problem.

A study of the sphincter muscles in these 210 specimens revealed no evidence of involvement of the external sphincters with cancer. However, in 17 cases, approximately 40 per cent, of the specimens in which the lower border of the lesion was 2 centimeters or less above the levators (approximately 5 cm. above the anal margin) the internal sphincter muscle was involved by the tumor. A definite decrease in the 5 year survival rate was found in patients of this group as compared to patients with lesions at a comparable level but without involvement of the internal sphincter. It would appear, therefore, when considering sphincter-preserving procedures, that saving the external sphincter is not contraindicated. However, the preservation of the internal sphincter in lesions 5 centimeters or less above the anal margin is inadvisable.

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SPLENECTOMY FOR PURPURA HEMORRHAGICA

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NO method of treating thrombocytopenic purpura has yet been discovered which is completely effective in all cases. While splenectomy has proved to be the most effective means of dealing with the idiopathic form of the disease, it is not uniformly successful. It has consequently seemed desirable to review periodically our results with this operation, for it is only by means of the long term, conscientiously documented follow-up that they can be accurately appraised.

The etiology, pathology, and diagnosis of thrombocytopenic purpura will not, therefore, be considered. The principal concern of this paper is the ultimate result of splenectomy.

FOLLOW-UP

The first splenectomy undertaken at the Presbyterian Hospital for idiopathic thrombocytopenic purpura was performed by Dr. Allen O. Whipple in 1924. Since then, 68 additional patients with the same ailment have undergone this operation, and of these only 1 has been lost to follow-up. This series is therefore composed of 68 patients who have been followed sufficiently for study. It covers a 26 year period, in which the longest consecutive follow-up is 24 years. Forty-nine of the 68, or 72.0 per cent of the patients, have been followed for 4 years or longer. Table I gives the details of the length of follow-up.

AGE AT OPERATION AND SEX

Inasmuch as the problem of purpura in infants and children has been the concern of the pediatrics department, the present series omits consideration of the first decade of life. The youngest patient reported upon was 11 years old at the time of operation. The eldest was 54.

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There were 51 females and 17 males. Approximately this same ratio of 3 to 1 in favor of females has been widely reported by others. Of the 17 males, only 4 were more than 21 years of age. This, again, is in keeping with the traditional view that idiopathic purpura is seen only infrequently in men.

RESULTS

The results of splenectomy in idiopathic thrombocytopenic purpura are depicted in Table II. They have been classified under the four following headings:

1. *Died*, patients who succumbed to the disease, whether the immediate postoperative result was beneficial or not.
2. *Doubtful benefit*, cases in which the benefit from surgery was not clear cut.
3. *Marked benefit*, cases in which an occasional mild symptom, slow platelet rise, or other inconsistency has marred an otherwise perfect follow-up.
4. *Complete arrest*, instances in which operation was followed by a prompt and lasting rise in platelets and an immediate and persistent cessation of the bleeding tendency.

The first two categories comprise the unsuccessful results in this series. The last two constitute its successes. Out of a total of 68 cases subjected to surgery, a successful outcome was obtained in 49, or 72.0 per cent. The outcome was disappointing or unsuccessful in the remaining 19, or 28.0 per cent.

One of the most striking features of these results (Table II) is the fact that the great majority of favorable responses to splenectomy were obtained before the age of 31 years. Only 1 of the 42 patients under that age died from a recurrence of purpura, while 4 such deaths occurred among the 26 patients in the older group. Among the 15 patients operated upon in the third decade of life, there have thus far been no failures. In terms of successful results (Table II), it would appear that in the age group before 31 years a favor-

TABLE I.—LENGTH OF FOLLOW-UP IN 68 CASES OF IDIOPATHIC PURPURA SUBJECTED TO SPLENECTOMY

Duration, years	No. cases	Total
Under 4 years		
Less than 1	5	
1– 2	5	
2– 4	9	19
Over 4 years		
4– 8	17	
8–12	20	
12–16	6	
16–20	4	
20–24	2	49
Total		68

TABLE II.—RESULTS OF SPLENECTOMY IN 68 CASES OF IDIOPATHIC THROMBOCYTOPENIC PURPURA FOLLOWED FROM 2 MONTHS TO 24 YEARS

Age at operation Years	Unsuccessful results 19 (28.0%)		Successful results 49 (72.0%)		Totals
	No. died of disease*	No. doubtful benefit	No. marked benefit	No. complete arrest	
11—20	1	6	4	16	27
21—30	0	0	1	14	15
31—40	1	3	3	3	10
41—50	3	2	2	3	10
51—60	0	3	1	2	6
Total	5**	14	11	38	68***

*All deaths due to recurrence after temporary arrest. No operative or hospital mortality.
**These deaths occurred respectively: 8 mos., 18 mos., 19 mos., 25 mos., and 9 years following operation.
***One additional case not included because of no follow-up; immediate arrest following splenectomy.

able outcome after splenectomy may be expected in perhaps some four-fifths of the cases, as opposed to only about one-half of the later age group.

Also noteworthy is the fact that while there were 5 deaths from recurrence in the series, there was no operative or hospital mortality. The latter fact suggests that removal of the spleen in the presence of the condition is no longer as dangerous a procedure as was once thought. The change in this concept must be largely ascribed to advances in anesthesia and in shock therapy.

In view of the foregoing trends, and providing the circumstances warrant it, once the diagnosis has been reached in younger patients, there should be no hesitation in recommending that operation be carried out without delay. On the other hand, inasmuch as after 30 the diagnosis of this condition is often more difficult and the results of splenectomy less favorable than before this age, surgery cannot be as unhesitatingly recommended as in the younger age group. Under no circumstances, however, should operation be withheld or delayed if there appears to be a reasonable chance that it may be of benefit.

BONE MARROW FINDINGS AND PROGNOSIS

In the past few years, a total of 11 smears of bone marrow have been made in 7 patients with purpura. The findings are in keeping with the experience of others (9). Megakaryocytes were usually found in normal or increased numbers, while distinct platelet formation in these cells was less frequent than it is in control marrows. It has been impossible in this small number of cases to form a fair judgment of the correlation between any abnormality of the marrow cells and the results of splenectomy. However, 1 patient whose disease was not at all benefited by the operation had abundant megakaryocytes in the marrow smear. Diggs and Hewlett could find no relation between the megakaryocyte count and prognosis.

As for the claim by Schwartz that "increased numbers of eosinophils in the marrow signify a favorable response for spontaneous recovery," it may be said that in this group of 7 cases only 1 showed marrow eosinophilia (15 per cent of granulocytes). That patient has had chronic and severe purpura, unrelieved by splenectomy, and marked by cerebral hemorrhage. Again, Diggs and Hewlett could find no relation between eosinophilia and prognosis. It appears therefore that the greatest value of bone marrow study in purpura is at the diagnostic level, where it provides assistance in the differentiation of leucemia, aplastic anemia, and other conditions. At the present time, decision as to splenectomy in idiopathic thrombopenic purpura rests rather on the clinical findings than on any visible changes in the megakaryocytes of the marrow.

TABLE III.—LOCATION OF ACCESSORY SPLEENS

Location	No. of cases
Pedicle	7
Gastrosplenic ligament	2
Beneath tail of pancreas	1
Retroperitoneum over left kidney	3
Not given	4
Total	17

ACCESSORY SPLENIC TISSUE

The role of residual or accessory splenic tissue in those patients who fail to respond to operation or suffer a recurrence subsequent to splenectomy is a matter of considerable importance. It assumes especial significance for the surgeon who must shoulder the ultimate responsibility of reoperating in the hope of finding this type of tissue, when the original operation has proved a failure and cerebral hemorrhage either threatens or has occurred.

Doan, Curtis, Thorek, and others have written extensively on the subject and emphasize the importance of exploration not only in instances of congenital hemolytic jaundice which recur following splenectomy, but also in idiopathic purpura. Their argument rests perhaps on a sounder basis for the former disease than for the latter, for of the failures in the present series 3 were thoroughly explored by competent observers, yet no trace of splenic tissue was found. In 1 instance this procedure was carried out at postmortem examination in a patient who succumbed with cerebral hemorrhage in a fulminating recurrence, and in the other 2, who also had severe recurrence following splenectomy, at exploratory laparotomy. It must therefore be concluded that not all cases of purpura which recur following splenectomy are due to accessory or residual splenic tissue not apparent or overlooked at the original operation. This, however, does not lessen the advisability of reoperating upon these patients in carefully selected instances.

The location of accessory spleens found at the time of splenectomy in this series is given in Table III. It will be noted that they were encountered 17 times, or in 25.0 per cent of the cases. This figure corresponds in general with those given by other authors. A uniform policy of thoroughly searching for and removing this type of tissue at splenectomy has been observed, and it is of interest that, among the 17 cases in which accessory splenic tissue was encountered, there were 13 successful results and 4 failures. The overall results of splenectomy in this group, therefore, do not appear to differ significantly from those in the remainder of the series.

TABLE IV.—RESULTS IN 25 CASES OF PURPURA WITHOUT OPERATION

	No. cases	Total
Unsuccessful results (72 per cent)		
Died	3	
Doubtful benefit	15	18
Successful results (28 per cent)		
Marked improvement	7	
Complete arrest	0	7
Total		25

RESULTS WITHOUT OPERATION

A word should be said about the conservative management of idiopathic purpura. It has been our experience that, with few exceptions, these cases fall roughly into two categories: those in which the disease is so mild that operation is either considered unnecessary or is refused by the patient, and those in which the disease is so severe that death ensues before operation can be undertaken.

Our experience with 25 conservatively treated cases is summarized in Table IV. It is of significant interest that the results in this control series are almost exactly opposite to those in the group operated upon, viz.:

	Successful cases per cent	Failures per cent
Operated group	72.0	28.0
Control group	28.0	72.0

From Table IV it will be noted that there were 3 deaths in the conservatively treated series. These were due to cerebral hemorrhage and, as intimated, took place before operation could be undertaken.

Two other patients, not included in these figures, also died of cerebral hemorrhage before splenectomy could be performed. One of these had disseminated lupus and the other an undiagnosed systemic disease. Thus, there

TABLE V.—MORTALITY FIGURES FOR IDIOPATHIC PURPURAS

	Total No. cases	No. died, operation	No. died, disease
Idiopathics with operation	68	0	5
Idiopathics without operation	25	—	3
Total	93	0	8

were 5 patients with thrombopenic purpura who died suddenly of cerebral hemorrhage while under medical management.

In hindsight, it seems likely that splenectomy, had it been done in time, might have saved some of these patients or at least produced a temporary remission of their bleeding tendency. While this was not possible in 1 instance because of the moribund state of the patient on admission, there was ample time for surgery in the other 4 cases. In each of the latter, however, the opportunity was lost because the true severity of the disease was not appreciated.

MORTALITY AND CEREBRAL HEMORRHAGE

Table V depicts the mortality figures for the entire group of idiopathic purpuras. Because much has already been said regarding these figures earlier in the report, only a few points remain to be discussed. It should be noted that in the entire series of 93 cases, 8 or 8.6 per cent, succumbed to their disease whether they were operated upon or not. Also, it is worth emphasizing that 7 out of the 8 deaths due to this disease were caused by cerebral hemorrhage. The eighth death, in all probability also attributable to this complication, has not been definitely classified as such because in this instance exitus was unexpectedly sudden, not observed, and no post mortem examination was obtained. There are 5 additional patients who have survived cerebral hemorrhage. Thus the incidence of this serious and often fatal complication is represented by a total of 12 patients, or 12.9 per cent of the entire series.

SPLENECTOMY IN SYMPTOMATIC PURPURA

In the opinion of Wintrobe (10), "splenectomy is contraindicated in (1) cases of doubtful diagnosis and (2) cases of 'symptomatic' or 'secondary purpura' such as those associated with acute infections or caused by the taking of some drug." Certainly the general principle set forth is sound and amply supported by long experience of the tragic results that may follow removal of the spleen when the diagnosis of idiopathic purpura is in error. Nevertheless, some case reports have appeared which suggest that the rule-of-thumb quoted may deserve some minor modification. Thus, Bruschi and Howe, reviewing the blood dyscrasias associated with Boeck's sarcoid, report that a patient with sarcoidosis and thrombopenic purpura was observed to have a prompt and sustained remission of bleeding after splenectomy. They cite 3 other similar case reports and in these too, splenectomy is judged to have exerted a beneficial effect. Mettier, McBride, and Li treated 1 patient with purpura due to gold therapy by removal of the spleen and observed complete disappearance of the abnormal tendency to bleed. It is recognized that a few scattered case reports of apparent benefit from any therapeutic measure in a disease so varied and so poorly understood as purpura must be viewed with skepticism. The possibility exists, however, that further experience may establish the validity of such observations and it seems therefore worth while to set forth here the results of splenectomy in 10 additional cases of "symptomatic" thrombopenic purpura.

Over the past two decades and more it has been the policy of both surgeons and internists of the Presbyterian Hospital not to recommend removal of the spleen in thrombopenic purpura other than idiopathic. However, by virtue of mistakes in diagnosis, or the compelling need for a trial of surgical therapy in spite of some uncertainty of diagnosis, splenectomy has been performed in a small number of cases that must be classed as "secondary purpura." There are two major points of interest about this group, to wit, (a) the clinical benefit brought about by splenectomy has been surprisingly great and approximates the results seen in idiopathic purpura; (b) the purpura has been secondary to three clinical conditions—granuloma of the spleen, idiosyncrasy to gold, and lupus erythematosus

disseminatus. A summary of the data in 10 such cases is given in Table VI.

Cases 1, 2, and 3 probably represent sarcoid of the spleen. The histological sections suggested that diagnosis and no acid-fast organisms could be demonstrated. The clinical findings did not disclose disease elsewhere. In all 3 splenectomy produced a most satisfactory remission of the purpura.

Cases 4 and 5 represented probable and proved tuberculosis, respectively. Both patients died.

Cases 6, 7, and 8 may properly be viewed as toxic reactions to gold therapy. It is true that all of these patients also had had discoid lupus of the skin. In none, however, has the disease developed into the disseminated type, and whereas purpura is a familiar complication of the therapeutic use of gold it is not likely to be seen in simple discoid lupus of the skin (6). In at least 1 of 3, splenectomy was followed by immediate cessation of bleeding.

Cases 9 and 10 are examples of lupus erythematosus disseminatus, proved by autopsy. Thrombopenic purpura constituted a dramatic episode in the course of this fatal disease, and in each instance the abnormal bleeding stopped after removal of the spleen. The underlying disorder was not influenced.

It is perhaps noteworthy that all 10 of these patients were female.

The results lend support to the suggestion, noted previously (5), that, in certain carefully selected symptomatic purpuras, if bleeding is severe and threatens life or if the hemorrhagic manifestations are unduly prolonged, splenectomy should be considered. It is not intended that this idea should embrace the purpuras seen in the course of leucemia, aplastic anemia, acute infections, or chronic diseases such as nephritis. Nor is it intended to imply that operative interference should be contemplated in purpura due to drugs. With the exception of gold, most chemicals that cause purpura are eliminated rapidly from the body and their withdrawal therefore almost always is quickly followed by disappearance of abnormal bleeding. Furthermore, in purpuras due to idiosyncrasy to gold, the therapeutic use of BAL is likely to take precedence over any other form of management.

TABLE VI.—RESULTS OF SPLENECTOMY IN SYMPTOMATIC PURPURA

Patient	Age	Sex	Duration of purpura	Platelet count	Results of splenectomy	Remarks
1 S.C.	21	F	3 mos	27,000	Complete arrest	Boeck's sarcoid or tuberculosis of nodes at splenic hilus. Perfectly well 7 yrs. after operation
2 F.H.	23	F	2 yrs.	6,000	Complete arrest	Miliary tubercles of spleen. No acid-fast organisms. Follow-up 2 yrs. 9 mos.
3 L.T.	35	F	28 yrs.	27,000	Complete arrest	Scattered foci in spleen proving histologically to be sarcoid. Perfectly well 1 yr. later
4 L.L.	57	F	3 mos.	21,000	Died 3 mos. postop.	Tubercles of spleen. Probably tuberculosis, possibly Boeck's sarcoid. No autopsy
5 R.P.	27	F	1 yr.	55,000	Doubtful benefit	Died 1 yr. postop. Extensive caseous and miliary tuberculosis
6 B.G.	27	F	1 yr.	6,000	Doubtful benefit	Received gold for skin lupus, arsenic for syphilis. 9 yrs. postop. has chronic skin lupus
7 I.J.	23	F	2 mos.	30,000	Complete arrest	Prompt cessation of bleeding. Well 16 yrs. later. Received gold for lupus of skin
8 N.K.	35	F	2 mos.	29,000	Doubtful benefit	Slowly improved after operation. 8 yrs. later well. Had received gold for discoid lupus
9 L.H.	37	F	1 mo.	6,000	Complete arrest	6 mos. later developed arthritis and died of disseminated lupus. Purpura did not recur
10 R.S.	20	F	2 mos.	4,000	Complete arrest	4 yrs. later died of disseminated lupus. Purpura did not recur

CONCLUSIONS

It would appear that the position of splenectomy as a therapeutic measure in idiopathic thrombopenic purpura has gained support from clinical observations carried out over many years postoperatively. The immediate benefit that is so often seen after removal of the spleen is usually sustained indefinitely. Furthermore, the mortality rate from the surgical procedure itself should be so low that it can rarely be urged as a contraindication to splenectomy in the face of bleeding that is incapacitating or threatens life.

It has been our unfortunate experience to have underrated the potential violence of the purpuric process in several patients and to have therefore withheld surgery from them,

only to witness fatal cerebral hemorrhage not long after. It is this unpredictable character of the disease, which may defy even the most experienced clinical judgment, that makes it necessary to consider splenectomy in all but the mildest examples of purpura hemorrhagica.

As for the "symptomatic" purpuras, experience is too limited to permit anything more than the suggestion that splenectomy may occasionally have a place in the management of certain types. After gold therapy, in Boeck's sarcoid and in lupus erythematosus disseminatus, splenectomy has been of use in controlling bleeding that has been severe. This is an interesting fact for those caring to speculate on the interrelationships and the pathogenesis of the purpuras but it does not materially alter the validity of the general principle that "secondary" purpuras should be managed medically and surgery reserved for the idiopathic thrombopenic type.

SUMMARY

1. The results of splenectomy for purpura in the records of the Presbyterian Hospital are reviewed.

2. Of 68 cases of idiopathic purpura subjected to splenectomy, 49 (72.0 per cent) are judged to have benefited materially from the operation. Almost three-quarters of these 68 cases have been followed for more than 4 years.

3. The utility of splenectomy for "symptomatic" purpura is discussed in the light of the results of operation which were obtained in 10 such cases.

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COLLOID CYST OF THE THIRD VENTRICLE

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OF all intracranial tumors colloid cyst of the third ventricle is the most constant in its situation and extent. It is invariably placed at the foramina of Monro and is attached to the choroid plexuses of the lateral ventricles where these structures become continuous with the small veins of Galen. Its primary pathological effect, and indeed the only one which endangers life, is hydrocephalus from obstruction of the foramina of Monro. In these circumstances it might be expected that the clinical picture would be a fairly constant one, but in the event there are such wide variations and so few features which distinguish it from raised intracranial pressure of other lesions, a positive diagnosis would be virtually impossible without ventriculography.

We have collected 19 cases of colloid cyst (Table I), 2 of which have so far not been verified though showing clearly in ventriculograms, and have found a further 142 cases in the literature. The main purpose of this paper is to discuss the diagnosis, treatment, and the late results of operation, but we also propose to consider the evidence which these cases afford on the function of those parts of the brain which lie adjacent to the cyst.

Pathological Anatomy

The cyst is unilocular, with a thin collagenous wall and a lining of cubical or columnar epithelium, sometimes ciliated. In our cases the epithelial lining was usually a single layer, but it may be multiple. The cyst is filled with a clear viscous fluid which sometimes clots in vivo. This fluid usually contains cholesterin crystals and may be turbid from the presence of foam cells, even looking like pus. The cyst is enclosed within the tela choroidea (Sjövall, 1909), which occasionally is thick enough to obscure it at operation; the membrane must then be stripped through the foramen of Monro before the glistening cyst wall is revealed. The choroid plexuses of the lateral ventricles at their origin at the foramina of Monro extend forward on its lateral margins to a variable extent (Fig. 1), and the small veins of Galen lie behind it.

The cyst is bounded in front by the anterior columns of the fornix, to which it is occasionally attached; behind by the central gray commissure of the third ventricle. Below, it projects into the anterior part of the third ventricle (Fig. 2); above it is the body of the fornix, and if the cyst is large it may project upward into the floor of the lateral ventricles (Fig. 3). There may then be gross destruction of the overlying fornix, and occasionally of the corpus callosum (Ross, 1917). Laterally the tumor may press upon the anterior tubercle of the thalamus.

In our series the cyst varied in size from 0.5 to 2.5 centimeters in diameter, but may be larger (Zeitlin and Lichtenstein, 1937). The smallest cysts are symptomless (Cairns, Calvert, Daniel and Northcroft, 1947)*. When the cyst reaches about 1.0 centimeter in diameter it may expand forward to obstruct the foramina of Monro, and symptoms of hydrocephalus appear. Acute obstruction is probably due to slight alteration of position of the cyst, since both its onset and spontaneous cessation may be sudden. When the foramina of Monro are completely blocked, the intense rise of pressure in the lateral ventricles produces a series of brain herniations of which the best known are herniation of the hippocampal gyri into the tentorial opening and of the cerebellar tonsils into the foramen magnum. These herniations may produce further rise of intracranial pressure and compression of the brain stem. In addition, there is probably also at times a downward displacement of the

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*Dr. Harvey Cushing himself was found at necropsy to have a colloid cyst of the third ventricle (Fulton, 1946).

whole of the brain stem (Fig. 4). Stookey (1934) suggests that the cyst may also obstruct the small veins of Galen at the time of impaction, with resultant venous engorgement of the corpus striatum and of the choroid plexuses of the lateral ventricle. These are the mechanisms which may contribute to sudden death from acute hydrocephalus.

The intensity of the obstruction varies from case to case, and in the same case from time to time. Some patients develop an acute obstruction before their lateral ventricles have had time to dilate much, while in others the ventricles dilate gradually through the years without symptoms of acute obstruction. In these the septum lucidum stretches and tears, so that there is a free communication between the lateral ventricles; but no by-pass of the cerebrospinal fluid into the subarachnoid space, or into the distal part of the third ventricle, becomes established.

Clinical Aspects

All would agree that colloid cyst of the third ventricle cannot be definitely diagnosed without the use of ventriculography (Fig. 5, a and b). Nevertheless, for a variety of reasons it is essential that the neurologist should be so familiar with the clinical states produced by the lesion that he suspects its presence before resorting to accessory methods of diagnosis. Sudden death, often in the small hours of the morning, has occurred in about 1 in every 5 of the reported cases of colloid cyst, either in the first or subsequent attacks of acute obstruction. Doubtless the frequency of this event will be reduced with more prompt recognition and operation, but all cases of this condition are potentially hazardous, and patients can be lost from failure to recognize the urgency of the condition, or from faulty planning of the use of accessory diagnostic methods and of the operative program.

1. In any given case of raised intracranial pressure there is need to decide whether to employ arteriography or ventriculography. In Britain the present tendency is to use arteriography in suspected tumors of the cerebral hemisphere, and ventriculography in suspected tumors of the third ventricle and posterior fossa. Some colloid cysts masquerade clinically as hemisphere tumors; in these, arteriography fails to reveal the site and nature of the lesion and merely indicates the presence of hydrocephalus.

2. In ventriculography for suspected colloid cyst it is essential that the replacement of cerebrospinal fluid by air should be as complete as possible; otherwise all that the ventriculograms may show is obstruction at the level of the foramina of Monro and the clinician may be left in doubt as to whether he is dealing with a massive irremovable tumor of the third ventricle which should be treated by ventriculocisternostomy, or a colloid cyst which should be removed. In any case the final decision on this question should be made partly on clinical judgment as well as on x-ray appearances, though Bull and Sutton (1949) have recently improved the ventriculographic interpretation of colloid cysts.

3. There is abundant evidence that after ventriculography patients with colloid cyst may quickly collapse and die unless the air injection is promptly followed by operative removal of the cyst or decompression.

For these reasons reliance on ventriculography to the exclusion of clinical studies may lessen the chances of a successful result following operation. An additional reason for knowledge of the clinical pictures produced by colloid cyst is the fact that in a few of the reported cases the patient has been sent in the first instance to a mental hospital.

Hydrocephalus

Excellent accounts of the symptoms of colloid cyst have already been published (Dandy, 1933; Stookey, 1934; Zimmerman and German, 1933) and therefore we do not intend to deal with the subject comprehensively. Variations in the clinical picture depend to a considerable extent on the completeness and suddenness of the obstruction of the foramina of Monro. (1) At the one extreme, when the obstruction is sudden and complete, there is usually an attack of violent headache with vomiting which may lead to unconsciousness, fixed pupils, and sudden death (Case 1), or may subside spontaneously and completely, to recur after a varying interval (Cases 8, 9, 10). (2) At the other extreme, when the obstruction is gradual, headache may be inconspicuous or absent and the main symptoms may be organic dementia (Riddoch, 1936; also our Case 5), or failure of vision (Case 7), or attacks of various kinds which are also found in the following group. (3) In between is the third and largest group in which the presenting symp-

toms are those of a progressive rise of intracranial pressure, punctuated by acute attacks of hydrocephalus, of which the main symptom is usually headache, but may take various other forms: amblyopia, coma, transient confusion or feeling of unreality, falling without loss of consciousness, sudden weakness of one upper limb, vertigo or tinnitus, attacks of numbness of the hands, or hallucinations of smell or taste. Case 9 showed an array of these attacks which merit closer attention than we are able to give them.

In the course of its evolution any case may pass from one group to another, and in all groups there may be complete remission of symptoms.

The following cases illustrate some of the clinical differences encountered.

Intense Headache with Stupor, Coma or Sudden Death

CASE 1. *Colloid cyst of third ventricle. Sudden death.* This patient was not seen by us and we are indebted to the late Dr. Charles Miller and Dr. Michelmore for allowing us to mention it. The patient was a female aged 46 years, who, while on a visit to the country, asked Dr. Michelmore to treat her hemorrhoids. This was successfully done by injections of quinine and urea hydrochloride. One week later she complained of abdominal pains, thought to be due to gallstones. On the next day she had intractable headache. This was not relieved by the usual analgesic and sedative drugs, and on the following day became so intense that she screamed with the pain and was given morphia, ¼ grain. Next morning she was found dead in bed. At postmortem, Dr. Miller found no disease of the body generally apart from gallstones. Both lateral ventricles were dilated and in the third ventricle was an amber-colored cyst, the size of a hazel-nut, attached to the choroid plexus.

Sudden death with intracranial tumor is not limited to colloid cysts. We have seen it with tumors of almost every part of the brain. But with colloid cysts the incidence of sudden death is significantly higher than with any other tumor.

CASE 10. *Colloid cyst of third ventricle. Three weeks history of headache. Operation: Removal of colloid cyst. Meningitis. Death.* Mrs. B., aged 30 years, was seen by the late Dr. George Riddoch on October 11, 1936. She had been perfectly healthy until 4 weeks before when she had a slight cold. One week later after sexual intercourse she had violent headache and vomiting. These symptoms passed off completely in a few days, but on the night of October 8, again after sexual intercourse, she had violent frontal headache. Next day she went about her affairs, but headache recurred in the evening and persisted on the following day. It could be partly relieved if she kept her head absolutely still. On October 11 at 2 a.m. she wakened screaming with pain which continued during the day and was accompanied by vomiting; by nightfall she was stuporous and incontinent of urine.

Examination. Dr. Riddoch could not rouse her. Her temperature was normal, pulse rate 50, respirations periodic. Her neck was a little stiff. The margins of her optic discs were blurred. The pupils were dilated and reacted poorly to light. The right side of her face drooped a little. The abdominal reflexes were diminished, there was an extensor plantar response on the left side and an equivocal response on the right. Blood pressure was 120/80.

The acute character of the illness and the severity of the headache raised the suspicion of subarachnoid hemorrhage, and lumbar puncture was done. The fluid was clear, under great pressure, and contained 2 cells per cubic millimeter and 25 milligrams per cent of protein. After lumbar puncture, the respirations improved, but she remained unconscious for the rest of the night.

On October 12 she was admitted to hospital. She could now be roused at times, but she was profoundly lethargic, confused and often restless, and would answer only in monosyllables. She still suffered from headache, limited to the frontal region, but she no longer screamed with pain. Respirations were 14 per minute, deep and regular; her temperature had risen to 100 degrees; and her pulse remained slow. Neck stiffness had passed off. There was ptosis and slight venous engorgement of both upper eyelids. The right pupil was now larger than the left, and still sluggish to light, and there was slight weakness of the left external rectus. The limbs were now hypotonic, the tendon jerks still brisk and apparently normal (though the increase of their briskness immediately the lesion was removed suggests that they were in fact relatively depressed). The left plantar reflex was still extensor, but the right now was flexor in type. As far as could be determined, sensibility was normal. The urine contained no sugar or albumen. X-ray films of the skull showed slight erosion of the dorsum sellae. She vomited several times on the x-ray table.

By nightfall, there was no improvement in her condition, in spite of magnesium sulfhate by rectum, and so she was given 80 cubic centimeters of 50 per cent glucose intravenously, after which she obtained relief from headache and slept for the first time for 4 days. The right pupil now reacted better, but there was still no improvement in her pulse or respiration rate.

Diagnosis. The suggestion was advanced that this might be a colloid cyst of the third ventricle, on the following grounds. Subarachnoid hemorrhage had been excluded by

TABLE I.—SUMMARY OF 19 CASES OF COLLOID CYST OF THIRD VENTRICLE (2 UNVERIFIED)

Case No. and initials	Hospital No.	Date of admission	Age Sex	Presenting symptoms	Length of history	Remissions	Physical signs	Operation	Death or recovery	Results	Time for follow-up	Remarks
1	—	—	46 F	Intense headache. Found dead in bed	1–2 days	None	—	None.	Death	Autopsy	None	Reported in text
2 L.M.	30222	2–9–1936	27 M	Attacks of severe headache with dragging of left leg, dysphasia and vomiting "nervous breakdown"	9 mo.	None	Left hemiparesis. Severe head retraction during headaches	None	Death	Death 3 hours after lumbar puncture. Autopsy	None	Fig. 1.
3	—	—	M	None. Accidental finding at autopsy	—	None	None	None	Death	From meningitis following gunshot wound of head. Autopsy	None	See Cairns et al. (1947)
4 O.	1545	6–25–1934	48 F	Attacks of headache and vertigo. Loss of interest and memory. Severe headache followed by stupor and coma	6 mo.	None	Bilateral papilledema (R. J8 L. J8). Left-sided pyramidal signs. Demented	None	Death	2 days after ventriculogram. At autopsy uncinate and cerebellar tonsil herniation	None	Fig. 2.
5 H.N.	1658	9–14–1934	66 M	Attack of unconsciousness with glycosuria in 1923. Progressive organic dementia. Further attack of coma	12 yr.	For 9–12 yr.	No pupillary reaction to light. Left-sided pyramidal signs. Demented	Ventricular tap	Death	Autopsy	None	Reported in text. Fig. 3. Riddoch (1936, Case 1)
6 I.D.	7317	3–13–1940	53 F	Attacks of severe headache and vomiting. Brief attacks of unconsciousness with fullness of abdomen	12 mo.	None	Blurred discs (R.6/12. L.6/18). Incomplete right homonymous hemianopia. Slight right hemiparesis. Poor memory, reasoning and intellect	Right subtemporal decompression, March, 1940 followed by radiation therapy	Death	4 years after admission from x-ray necrosis of brain. Autopsy	None	Pennybacker and Russell (1948, Case 2)
7 W.R.	2232	5–17–1935	40 M	Right-sided sensory fits and failing vision. Attacks of bad temper. Family history of insanity	4 yr.	None	Bilateral optic atrophy. Minimal left papilledema (R. blind. L.2/12)	Removal of cyst	Recovered	Sight not improved. Outbursts of temper became much worse for 6 years, then lessened. One fit 2 years after operation, following ventriculography	15½ yr.	Reported in text
8 M.C.	2035	6–24–1935	34 F	Attacks of bursting headache. Glycosuria in one attack	5 yr.	Complete for 5 yr.	Bilateral papilledema (R. 6/8. L. 6/8)	Removal of cyst	Recovered	Fit 2 days after operation. Then free from symptoms. Married in 1946	15 yr.	Reported in text
9 I.M.	2793	3–15–1936	43 F	Tinnitus followed by a seizure. Irrational. Spontaneous recovery. 5 years later defective memory, attacks of headache, giddiness, weakness right arm and leg	8 yr.	Complete for 5 yr.	Bilateral papilledema (R. 6/6. L. 6/6). Inferior binasal hemianopia. Slight right hemiparesis. Organic dementia	Removal of cyst	Recovered	At first lack of insight and nocturnal delusions. Then free from symptoms	14 yr.	Reported in text
10 B.	2534	10–11–1936	30 F	Violent headache and vomiting, on two occasions	3 wk.	Complete for 17 days	See text	Removal of cyst	Death	From meningitis 35 days post operative	None	Reported in text

In Cases 1 to 6 tumor was not removed; in Cases 7 to 17 tumor was removed; Cases 18 and 19 not verified.

TABLE I.—SUMMARY OF 19 CASES OF COLLOID CYST OF THIRD VENTRICLE (2 UNVERIFIED)—Continued

In Cases 1 to 6 tumor was not removed; in Cases 7 to 17 tumor was removed; Cases 18 and 19 not verified.

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Case No. and initials	Hospital No.	Date of admission	Age Sex	Presenting symptoms	Length of history	Remissions	Physical signs	Operation	Death or recovery	Results	Time for follow-up	Remarks
11 J.P.	4272	9–14–1939	18 F	At age of 8 attack of vomiting and unconsciousness. For 6 weeks headache, vomiting, blurred vision	10 yr.	Complete for 10 yr.	Bilateral papilledema (R. 6/9. L. 6/6). Slight left facial weakness	Removal of cyst	Recovered	11 years after operation memory still uncertain. Working full-time. Gained 4 stone in weight 2 years after operation. Married. One child born 1946	11 yr.	
12 V.G.	8368	(1) 3–26–1940 (2) 2–5–1941	22 F	Attacks of severe headache with buzzing noises in right ear. Focal right-sided sensory fits. Trace of sugar in urine once	1 yr.	None	Bilateral papilledema (R. 6/6. L. 6/6). Slight weakness right hand grip	(1) Right frontal decompression June, 1940 (2) Removal of cyst Feb. 1941	Recovered	Free from symptoms for 3 years. Then developed acromegaly	9 yr.	Reported in text
13 M.C.	1030	1–8–1943	28 F	Attacks of severe headache and vomiting	4¾ yr.	Complete for 3½ yr. following decompression	Slight mental deterioration. Discs blurred (R. 6/9. L. 6/9). Left pupil reacts sluggishly to light	(1) Subtemporal decompression 1938. (2) Removal of cyst 1943	Recovered	2 fits in 1943, then free from symptoms. Married in 1946. Two children	7 yr.	Reported in text
14 F.R.	8429	6–5–1944	18 M	Attacks of severe headache and vomiting. Attacks of blurred vision. Failing memory and concentration	10 mo.	Complete for 2 wk. and again for 4 mo.	Memory loss and impaired concentration. Discs blurred (R. J1. L. J1). Poor conjugate deviation to right. Staggering to left when walking	Removal of cyst	Death	Sudden death 14 hrs. after operation. Autopsy	None	
15 J.G.	60736	8–3–1946	19 F	Attacks of violent headache ("influenzal meningitis"). Later failing vision	18 mo.	Complete for 6 wk.	Bilateral optic atrophy and slight papilledema (R. J14 L. J20). Drowsy, confused, with monosyllabic speech	Removal of cyst	Recovered	Free from symptoms except impaired sight. (R. J4. L. J16). Married 1947. One child born 1947.	4 yr.	
16 P.W.	87198	5–8–1948	21 M	Momentary attacks of narrowing field of vision. Severe headache, vomiting, listlessness	6 yr.	None	Bilateral papilledema (R. 6/5. L. 6/5). Somewhat casual, brusque and impolite	Removal of cyst	Recovered	Free from symptoms. Full work in police force	2 yr.	
17 D.P.	100890	2–18–1949	41 F	Attacks of severe headache and vertigo. Short amblyopic attacks	4 mo.	Incomplete for 3 wk.	Bilateral papilledema (R. 6/9. L. 6/12). Bitemporal hemianopia. Slight weakness of left lateral rectus	Removal of cyst	Recovered	Slight failure of memory, a little uninhibited. One fit 7 months after operation. Working	1½ yr.	
18 M.B.	74769	7–24–1947	18 F	One attack of headache. One attack of diplopia. Asymptomatic on admission	3 mo.	For 2 wk.	Bilateral papilledema. (R. 6/6. L. 6/6)	Right frontal dural decompression	Recovered	Papilledema slowly subsided. (R. J1. L. J1.). Returned to work. Married Sept. 1948. One child born 1949. Slight occasional headaches	3 yr.	Reported in text
19 W.L.	95393	10–30–1948	45 M	Failing vision, forgetfulness, dyscalculia. Tingling in right fingers. Difficulty in seeing to right	1 yr.	None	Papilledema (R. 6/9. L. 6/5). Right ptosis. Poor memory	Right frontal dural decompression	Recovered	Asymptomatic 2 years after operation (R. 6/12. L. 6/12).	2 yr.	

In Cases 1 to 6 tumor was not removed; in Cases 7 to 17 tumor was removed; Cases 18 and 19 not verified. Under "Physical Signs" and "Results" columns, disc measurement "J" refers to Jaeger method.

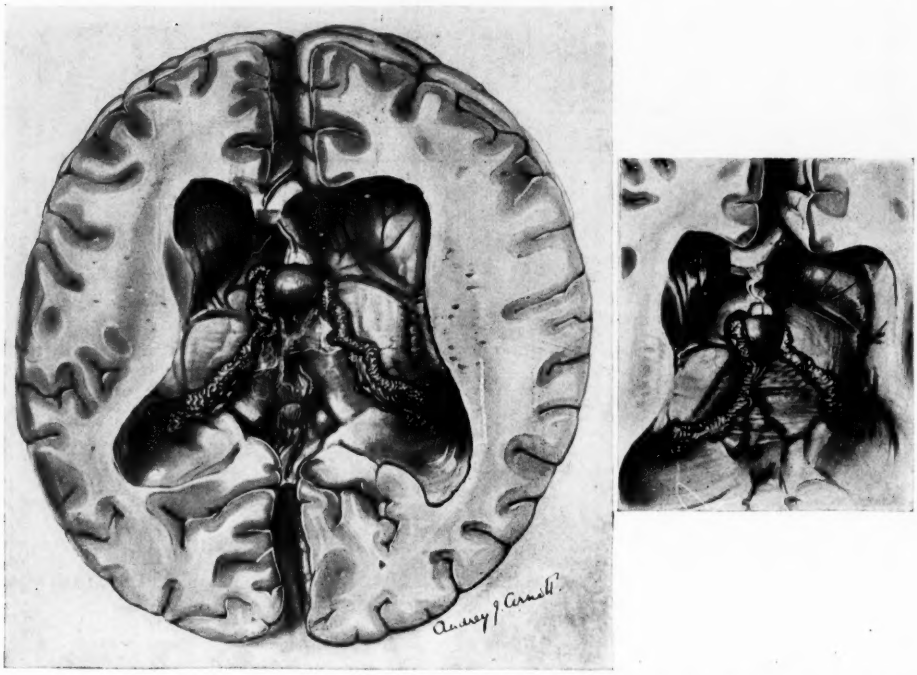


Fig. 1. Case 2. Colloid cyst, showing relationship of the cyst to the anterior columns of the fornix, the thalami and the choroid plexuses.

lumbar puncture. With such clinical signs as were evident, the condition was too sudden for any hemisphere lesion, and its characters were clearly those of acute hydrocephalus. Cerebellar tumor was unlikely because there were no cerebellar signs. Furthermore, the temporary remission after the first attack of headache was characteristic of a colloid cyst.

Course. Ventriculography confirmed the clinical diagnosis, and a colloid cyst of the third ventricle was found and removed. The patient did well for 1 week, but then developed meningitis due to a gram-negative bacillus from which she died 4 weeks later.

The predominant clinical characteristics of these 2 cases are the intensity of the headache and the rapid onset of stupor or coma. In the most severe form the patient may scream or groan during exacerbations of the pain. The pain is often intensified by movement of the head so that at the height of the agony the patient holds his head in his hands. On the other hand, change of posture may sometimes relieve the headache. The pain is most often frontal, but may be in any part of the head and may spread to the back of the neck and shoulders. The patient vomits in a projectile manner. Frequently he becomes confused, and may repeatedly shout, "Let me die," or some similar phrase. With the headache the pupillary and tendon reflexes become sluggish and the plantar responses extensor. At the height of the paroxysm the neck may be stiff, and this clinical picture may resemble that of meningitis or subarachnoid hemorrhage. The pulse slows, the respirations become periodic, and the patient may sweat profusely. The optic discs, at first normal, may early begin to show blurring of their margins.

The situation clearly demands urgent treatment and far too often that treatment is an injection of morphia which serves only to hasten the onset of coma. Even without morphia, stupor or coma often supervenes, and this may be followed by sudden death.

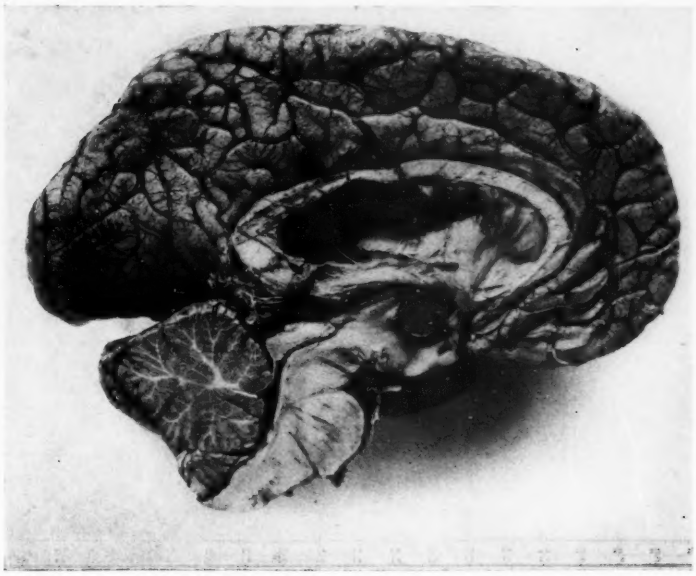


Fig. 2. Case 4. Colloid cyst obstructing the foramina of Monro.

Headache of the severity shown by these two patients is unusual in other forms of intracranial tumor. It should always arouse suspicion of a colloid cyst. However, it is by no means pathognomonic since we have seen similar intense paroxysms of headache as a result of an acute expanding lesion of the cerebellum, and with cystic tumors of the temporal lobe and other parts of the cerebral hemisphere. In these lesions, however, the incidence of intense headache is much lower than with colloid cyst, and in addition there are usually florid focal signs. Tumors of the lateral ventricle may also produce paroxysmal headache with stupor.

In the less severe attacks the headache though violent is not of screaming intensity and the patient remains fully conscious. In some patients the attacks of headache are of relatively short duration.

CASE 15. A girl aged 19 years had attacks of headache lasting 1 or 2 days, and accompanied by vomiting. They were described as bilious headaches, and were at times sufficiently intense to make her cry out; in the first attack which came on after influenza a diagnosis of influenzal meningitis had been made. The attacks recurred every 3 or 4 weeks, and in the intervals she was well and at work in a factory. After 18 months she noticed that her sight was failing and she was then sent to hospital. On admission she had moderate papilledema with severe optic atrophy and loss of sight.

Intermission of Symptoms

Spontaneous intermission of symptoms occurred in 9 of our 19 cases before operation (Table I). The interval of freedom from symptoms varied from 2 weeks to 10 years. The literature contains many cases showing complete freedom from symptoms for up to 9 years (Rinder and Cannon, 1933).

CASE 8. *Colloid cyst of third ventricle. Complete remission of symptoms for 5 years. Second attack with glycosuria. Operation: removal of colloid cyst. Recovery.* M. C., a seamstress, was admitted to the London Hospital in 1930 at the age of 29 years with a 3 weeks' history of severe headache increasing in severity. At that time she had bilateral papilledema (3D), with exudate and hemorrhages, and no definite localizing signs. She was treated with hypertonic salt, and within 3 weeks her symptoms had cleared up almost completely. She was discharged from hospital with the diagnosis of serous meningitis.

For the next 5 years she remained well and continuously at work. Then, in 1935, headache recurred. It was severe and bursting, lasting 2 hours at a time, recurring daily, and at its height was ac-

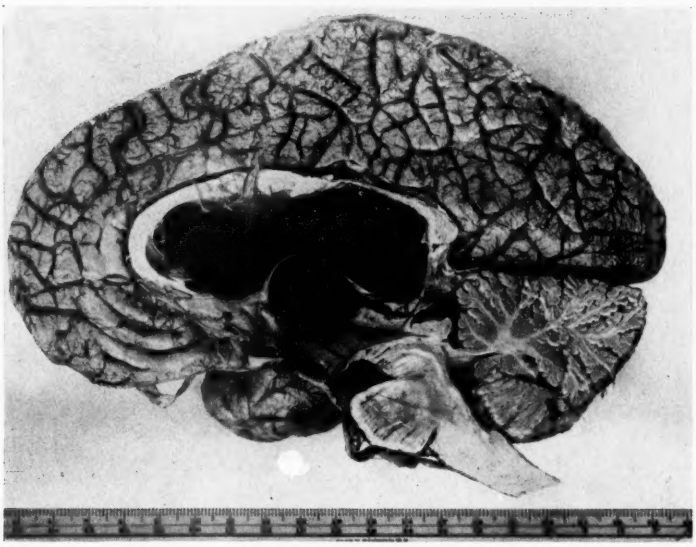


Fig. 3. Case 5. A large colloid cyst. Note the thinning of the overlying fornix, the severe dilatation of the lateral ventricle (which had produced fenestration of the septum lucidum), and the moderate dilatation of the third ventricle distal to the obstruction.

companied by stiffness of the neck and mistiness of vision. The attacks became uncontrollable, even with morphia, and she was readmitted to the London Hospital.

There was again papilledema, with preservation of good vision, but no other neurological signs. Her urine contained a trace of sugar on admission, but not subsequently. X-ray films showed thinning of the dorsum sellae. During the next 2 weeks her headaches became less severe and her papilledema subsided slightly.

The diagnosis of colloid cyst of the third ventricle was suspected on clinical grounds and confirmed by ventriculography (Fig. 6). The tumor was removed under local anesthesia on July 16, 1935 (Fig. 7), and, apart from incontinence of urine for a few days and a fit on the second day after operation, the patient made an uneventful and satisfactory recovery and soon returned to her work. She married in 1946. When seen in 1950, 15 years after operation she was well and free from symptoms. There had been no further fits.

CASE 9. *Colloid cyst of third ventricle. Severe illness with mental symptoms followed by complete recovery. Recurrence 5 years later. Attacks of various types. Operation: removal of cyst. Recovery.* Mrs. I. M., aged 43 years, referred by Dr. Russell Brain, was first seen in March, 1936. Because of mental disturbance she was incapable of giving a connected account of her illness, and the history was obtained from her husband, an intelligent male nurse. She had been quite well until 1930, 6 years before, when she began to complain of noises in the head. Shortly after this she had a seizure of some kind: She was unconscious for several hours and after recovery was irrational, refractory, and had to be fed. She was very ill for 2 months and her husband was told that she had an inoperable brain tumor, and was advised to have her transferred to a mental hospital. While he was considering the position she began to recover. She had at first some difficulty in walking and had to go about in a wheel chair, but by the end of 1930, 7 months after the onset of the illness, her recovery was complete.

Thereafter she led a perfectly normal and active life, and was free from symptoms, except occasional tinnitus and loss of libido, until March, 1935, when she had a severe attack of mumps. After that her husband found that her memory was a little defective, and this got steadily worse.

In March, 1935, also, she began to have attacks of weakness in the right upper limb, of sufficient severity to cause her to put objects down quickly lest she should drop them. Her right arm became gradually weaker and soon she began to drag her right leg in walking, and to an increasing degree. The head noises became more persistent and with them she began to have splitting vertical headaches, and in January a bout of protracted vomiting. At about this time during a severe headache she fell down without losing consciousness and was unable to move her legs for some minutes; afterward she was in bed

for 2 days. Before March, 1935, headaches had been a rare complaint.

She suffered also from momentary hallucinations of a foul odor, not associated with disturbance of consciousness or any other objective sign. On many occasions she was momentarily giddy, but did not fall. She also had attacks of numbness in her hands, and at times she was unable to release her grasp of objects. In 1936 her sight began to fail and she was frequently incontinent of urine.

Examination. The patient was a healthy looking woman. There was considerable fluctuation in her mental state, but at all times she showed a gross defect of memory for any but the most recent events, and especially for their time sequences. Her powers of concentration were usually grossly impaired. She had great urgency of micturition and occasional incontinence. At times she was tearful and depressed and tried to get out of bed.

She was not confused by the details of neurological examinations, but at all times she displayed finger agnosia and right-left disorientation. (This, we learned later, was a life-long disability in consequence of which she had always had difficulty in laying the table.)

She showed considerable fluctuation also in her organic signs, but the following signs were found on more than one occasion. There was slight impairment of smell at both nostrils and low grade papilledema (right, 2 D.; left, less than 0.5 D.; visual acuity, 6/6 in each eye). Incomplete lower binasal hemianopia. The pupils were small but reacted promptly to light and convergence. There was slight right facial weakness. All voluntary movements were slow and there was slight weakness of the right upper and both lower limbs (right more than left) with increase of tone in the lower limbs. The tendon jerks were brisk and equal, the abdominal reflexes were present but diminished; the plantar reflexes were at times extensor, at times flexor or absent. A pronounced grasp reflex was present in both hands and feet.

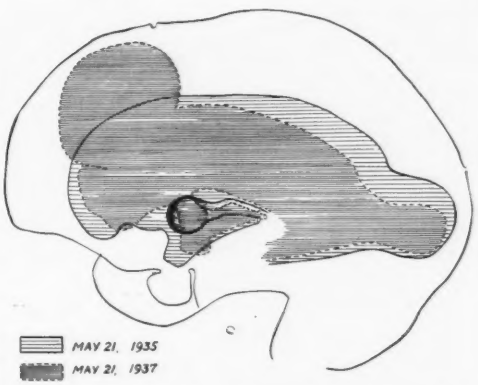


Fig. 4. Case 7. Superimposed ventriculographic tracings. Light hatching indicates the preoperative appearance. Heavy hatching indicates the appearance 2 years later, and shows (1) a frontal diverticulum corresponding to the area of frontal lobe resected at operation, (2) shrinkage of the lateral ventricle, (3) alteration in the situation of the third ventricle.

Postural sensibility was normal in the fingers, but defective in both big toes. A trace of albumen was found in the urine on two occasions. Fluid intake and output were normal.

X-ray films showed slight thinning of the dorsum sellae. Lumbar puncture yielded fluid under the initial pressure of 300 millimeters plus, containing 1 lymphocyte per cubic millimeter, and 45 milligrams of protein per 100 cubic centimeters.

No definite localizing diagnosis was made.

Ventriculography. March 26, 1936. From the lateral ventricles 180 cubic centimeters of cerebrospinal fluid under an initial pressure of 240 millimeters were replaced by air. There was great symmetrical dilatation of the lateral ventricles, least in the

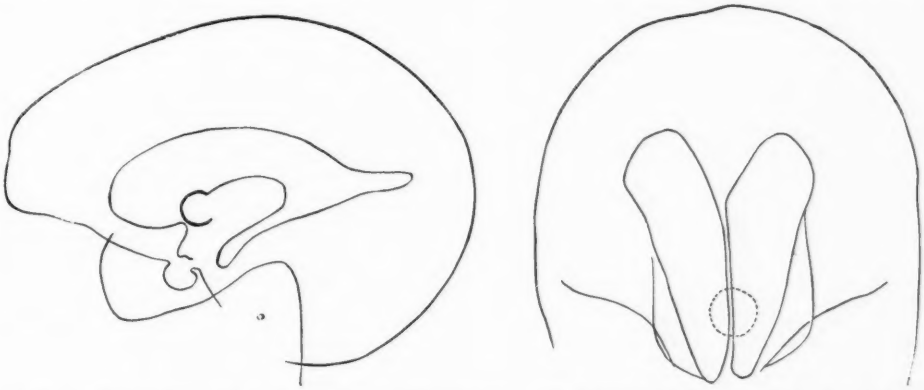


Fig. 5. Ventriculographic tracings showing outline of cyst: a, left, lateral; b, oblique anteroposterior projections.

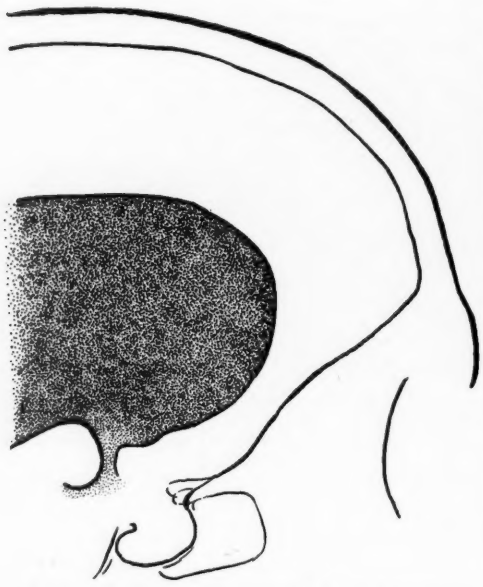


Fig. 6. Case 8. Ventriculographic tracing. Lateral projection with the patient in the face-up position.

temporal horns. At first in lateral views no air was seen in the third ventricles, but after further manipulations a small amount of air was shown in its anterior part with a concave posterior end which suggested the presence of a rounded mass behind. There was also a tiny collection of air in the posterior part of the third ventricle.

Operation. March 26, 1936. Local anesthesia. A right frontal flap was turned and the lesion was approached by the transventricular method (Fig. 8). After the right lateral ventricle was opened by excising part of the frontal lobe (5 by 4 by 3.5 cm.), extra room was obtained by puncturing the septum lucidum, thus releasing air from the opposite lateral ventricle. In this case the foramen of Monro (0.6 by 0.3 cm.) was not so large as in the other cases of this series and the cyst did not present obviously in it, but was covered by a thin film of grayish material which was probably tela choroidea. Above the foramen of Monro the fornix was bulging and looked thin. When this was incised the glistening wall of the cyst was revealed and good exposure was obtained by continuing the incision downward into the foramen of Monro.

The cyst was opened and emptied of its contents which consisted of clear yellowish viscid liquid and 3 white semisolid spherical masses, each about 0.3 centimeter in diameter. The cyst wall was so delicate and fragile that it proved quite impossible to remove it, or, indeed, to procure any of it for histological study. It dwindled almost to nothing after the cyst was opened and all that could be done was to destroy the fragile capsule with endothermy at the site of its attachment to the choroid plexus. It had no other attachments and after the cyst had been emptied the anterior part of the third ventricle could be well seen and cerebrospinal fluid was beginning to flow into it from the left foramen of Monro.

From her replies to questions during the operation it was evident that the release of the obstruction had had an immediate effect, for she answered more alertly and was better orientated than at any previous time during her stay in hospital. Manipulations in the region of the third ventricle produced no effects upon pulse, blood pressure, wakefulness, or blood sugar during the operation.

Postoperative course. At the end of the operation there was no trace of weakness from excision of part of the right frontal lobe, but 1 hour later when she was sleepy her left hand grip was a little weaker than the right and she turned her eyes less easily to the left than to the right. This did not persist. Involuntary grasping disappeared from the left hand and from both feet immediately after operation, and from the right hand on the following day. The plantar reflexes were at first extensor, but within a few days first the left and then the right became flexor. Her mental state showed immediate improvement: in the day-time she was quite lucid, but at night for the first 2 weeks she was still at times disoriented, deluded, and incontinent.

Her general condition gave rise to no anxiety, the wound healed by first intention, and she was discharged from the hospital on the 27th day after operation. There was general muscular weakness when walking, but she no longer suffered from headache, tinnitus, or olfactory hallucinations. Her mental state was improved, but she still showed a certain lack of insight into her condition, and was unable to sustain her attention. She had no coherent memories of her first illness in 1925.

On returning home her memory gradually improved and she resumed her housework. Within 3 months her husband reported that her mental state was practically normal. Libido likewise became normal again.

She was last seen at the age of 57 years in February, 1950. There had been no recurrence of mental symptoms, headache, or any other symptoms. During the 14 years since her operation she had been free from all symptoms and, once recovered from her operation, had done her housework continuously and well. She had nursed her husband through a trying illness which ended in his death, and she had gone through the London blitz with normal fortitude. With her tumor removed she was in fact a normal stable personality, and the long-standing hydrocephalus did not seem to have damaged her intellect. Her senses of smell and taste were still imperfect. Her optic discs were normal (J1 in each eye[1]) and there were no neurological signs. Her periods had ceased at 52 years.

[1] "J" refers to Jaeger method of measurement.

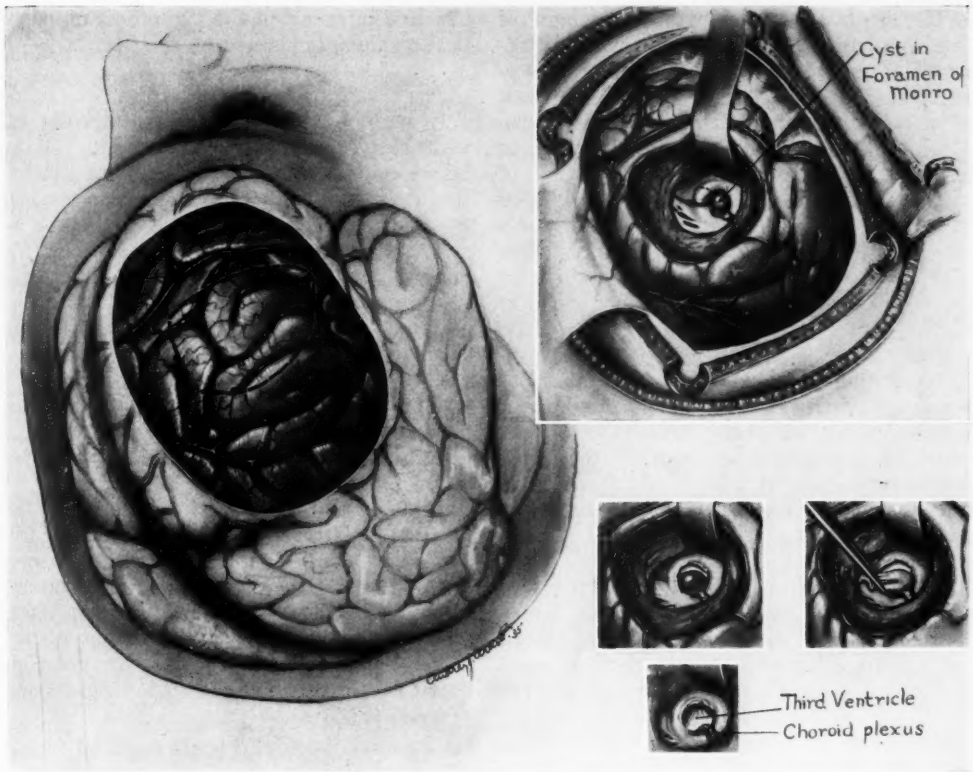


Fig. 7. Case 8. Sketches of the operation.

This case and the preceding one both showed complete remission of symptoms for 5 years. In other respects, although they had identical tumors and the same degree of hydrocephalus, they make an interesting contrast. In Case 8 the clinical picture was one of headaches and papilledema, with on one occasion glycosuria during severe headache, while in Case 9 the picture was one of organic dementia and a large variety of brief attacks which must be regarded as hydrocephalic; headache was a late and inconspicuous symptom. Both these patients have been observed for 14 and 15 years since their tumors were removed and there is nothing to indicate that the difference in the clinical picture of these two identical cases of hydrocephalus was due to the personality of the patient. In Case 9 the patient whose first symptoms were organic dementia proved later to be a woman of intelligence and stability, while in Case 8 the patient whose symptoms were only headache was a rather simple, emotional, uneducated woman. It seems to us more likely that the clinical variations depend partly on the completeness of the initial obstruction of the foramina of Monro and partly on anatomical differences within the skull. In Case 8 the patient had a small cranium, while in Case 9 she had a large one. The large head, we suppose, might allow dilatation of the ventricles and herniations of the brain before there was any great rise of intracranial pressure. The numerous types of attack which followed—attacks of falling, olfactory hallucinations and so forth—could be explained by temporary compression of the brain stem and uncinate gyri as a result of the brain herniations.

The contrast in the symptomatology of these patients indicates that from the diagnostic angle the intermission of symptoms is the point of greatest importance. We know of no other intracranial tumor in which complete remission of symptoms for long periods is so common. However, from the point of view of differential diagnosis it must be borne in mind that long intermission of symptoms may occasionally occur with other intracranial tumors. We have seen spontaneous intermission of symptoms with meningiomas of the hemisphere and with tumors of the lateral ventricle.[1] Sir Charles Symonds (personal communication) has had a case of cerebellar astrocytoma with remission of symptoms for 20 years; and in 1 of our cases of cystic astrocytoma of the right frontal and parietal lobes (No. 2376) there was a complete remission of symptoms for 20 years following a small temporal decompression.

Slight relief of raised intracranial pressure may be followed by an intermission of symptoms. Thus, in Case 8 headaches disappeared for 5 years after rectal instillations of magnesium sulphate. Of the 5 patients who were treated in the first instance by palliative decompression, 1 (Case 6) had partial relief while the 4 others had an immediate intermission of symptoms. In 2 of these cases symptoms recurred after 4½ months and 3½ years, respectively; while in the 2 other cases, which are not yet verified other than by ventriculography, the intermission still continues 2 years and 3 years, respectively, after decompression. The frontal and temporal decompressions which have been so successful in these cases can have no decompressive effect upon the foramina of Monro. All that they can do is to provide a slight safety valve against the rise of intraventricular pressure, and it is notorious that with tumors of the cerebellum or midbrain such decompressions of the cerebral hemisphere are not usually effective in relieving the symptoms of raised intracranial pressure.

[1]With tumors of the lateral ventricle, which may also resemble colloid cysts in causing intermittent stupor and paroxysmal headaches, the protein content of the cerebrospinal fluid is usually raised, whereas with colloid cysts of the third ventricle in 11 of our series the protein content of the cerebrospinal fluid was usually normal and never above 60 milligrams per cent, except in 1 case in which there is some doubt of the accuracy of the report. The cases in the literature confirm our findings.

The Mechanism of Hydrocephalic Symptoms

In many cases it is clear that the lateral ventricles are already considerably dilated before acute symptoms arise. Figure 4 shows that during an acute attack of hydrocephalus the floor of the lateral ventricles, the colloid cyst, and the third ventricle may be displaced downward. These facts suggest that the acute symptoms are associated with downward displacement of the cyst and consequent impaction in the foramina of Monro. Intermission of the symptoms is probably associated with disimpaction of the cyst: in some cases this may be due to alteration in the position of the head; or it may follow the use of hypertonic salt. The surprisingly beneficial effect of frontal decompression in diminishing the liability to acute hydrocephalic attacks indicates that the decompression suffices to prevent the build-up of pressure in the lateral ventricle without which downward displacement and impaction of the cyst cannot take place. All that happens is that the ventricle bulges out further into the area of the decompression (Fig. 14).

"False" Localizing Signs

Hemiparesis is a fairly common finding, but is usually mild in degree. In 1 of our cases (Case 6) it was accompanied by a homonymous hemianopia, which was associated with minor attacks suggesting a lesion in the temporal lobe. This picture led to an error of diagnosis after ventriculography had shown bilateral symmetrical hydrocephalus. A subtemporal decompression was made and then radiation treatment was given for a supposed thalamic and temporal tumor. The patient was relieved of her symptoms, but died 4 years later of radiation necrosis of the brain (Pennybacker and Russell, 1948).

FOCAL SIGNS

The clinical picture of colloid cysts is dominated by hydrocephalus and in the past it has been assumed by most writers that there were no focal signs. There is, however, good evidence that glycosuria occurs in a significant

number of cases, and that this is produced by local pressure of the cyst, which may encroach upon the upper part of the hypothalamus. There may also be other endocrine signs.

Endocrine Symptoms

Before considering the neurohumoral symptoms certain premises must be stated.

1. In man endocrine symptoms do not always appear after lesions of the hypothalamus itself[1], hence it is not to be supposed that a juxtahypothalamic lesion like colloid cyst will produce endocrine signs in more than a small proportion of cases.

2. Certain endocrine symptoms can be produced only by an *acute* cerebral lesion and then are only transitory; this is probably true of glycosuria from experimental lesions of the central nervous system.

3. We must beware of attributing all that is unusual in our patients to the presence of a colloid cyst; before making final conclusions as to the relationship of symptom and cyst it is necessary to observe the effect of removal of the cyst. Figures 9 and 10 illustrate this point: In Case 8 the patient was moderately obese at the time of removal of her colloid cyst; but a year later she was unchanged (Fig. 9), hence the obesity may have had no connection with the colloid cyst. By contrast, a patient with a suprasellar craniopharyngeal cyst was changed from obese to slim proportions by removal of her lesion (Fig. 10); her obesity was clearly due to compression of the hypothalamus and pituitary regions by the cyst.

Glycosuria. Sugar was found in the urine in 3 of our 19 patients. In Case 12 there was a trace of sugar on one occasion only. In Case 8 no glycosuria was observed in the first attack of headache, but in the second attack 5 years later the urine contained a trace of sugar during a period of severe headaches. Six days later, while the tumor was being removed, there was a rise of blood sugar. Unfortunately this observation is of little value since during the latter part of the operation the patient was given 60 grams of glucose in 600 cubic centimeters of normal saline. However, on

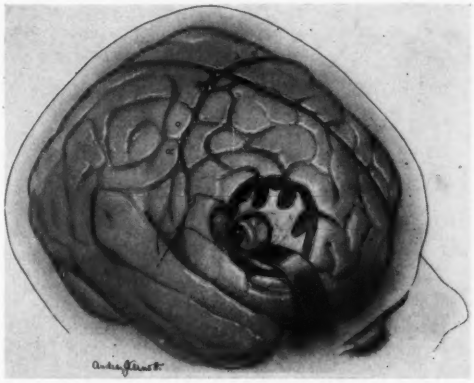


Fig. 8. Case 9. Diagram of the operative approach.

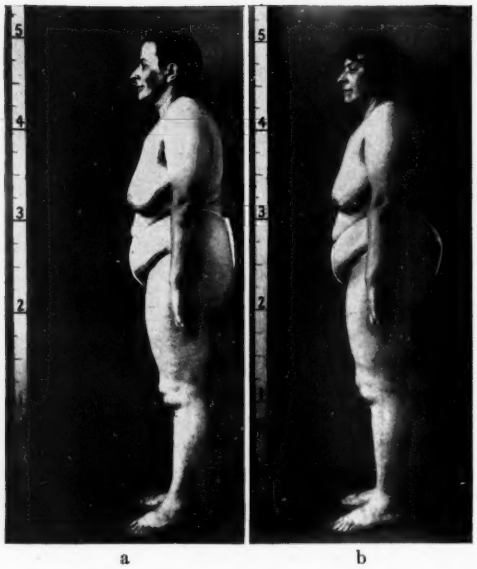
the evening of operation and for the next 3 days her urine contained sugar, and this is more than could be accounted for by the intravenous glucose during operation. Her blood sugar 18 hours after operation was 190 milligrams per cent., and at no time did her urine show acetone or diacetic acid. It would seem, therefore, that the main abnormality here was a lowering of renal threshold.

In Case 5 of our series the glycosuria was also transitory.[2]

CASE 5. *Colloid cyst of third ventricle. Progressive mental deterioration in adult life. At age of 55, attack of coma with glycosuria. At age of 66, severe dementia. Ventriculography. Death.* H. N., a man aged 66 years, was admitted to the London Hospital in coma in 1934. He had been a scholar at a public school and a fairly good cricketer, but had subsequently failed in a responsible position and had spent the last 40 years of his life as a rather ineffective clerk in his brother's office. For years he had suffered from headaches. In 1923 while in a tea shop he felt faint, vomited and became unconscious. He was admitted to the Middlesex Hospital where he was found to have sluggish pupils, 3 per cent of sugar in his urine and 129 milligrams per cent sugar in his blood. He was given 20 units of insulin and 2 hours later his blood sugar was 57 milligrams per cent, and urinary sugar was 0.3 per cent. He recovered from this attack in 2 days and discharged himself from hospital. After this he remained well until 1931, when he became increasingly tired, lethargic, and forgetful. In 1934 he was found unconscious in the street and was admitted to hospital.

[1]The reader is referred to the penetrating analysis of hypothalamic symptomatology by Norman Dott (1938), for a rational explanation of this fact.

[2]This case has already been reported by Riddoch (1936), but he did not give the details of the disturbance of carbohydrate metabolism since he was concerned with other aspects of the case.



a b

Fig. 9. Case 8. Appearance of patient, a, within a few days of removal of her colloid cyst, and, b, 1 year later.

Examination showed an emaciated man who was apathetic, drowsy, and demented. The following signs were found: small irregular pupils which were fixed to light, left lower facial weakness, a grasp reflex in the right hand, diminished tendon jerks and extensor plantar reflexes. The optic discs and visual acuity were within normal limits. Blood sugar 110 milligrams per cent. No sugar or albumen in the urine.

The patient died 2 days after ventriculography and necropsy showed a colloid cyst (2.5 by 2.2 by 1.8 cm.) in the usual position (Fig. 3).

Thus, in our 3 cases the glycosuria was transitory and as far as we could determine was associated with little or no rise of the blood sugar level. In the literature we have found 7 cases in which there appears to have been glycosuria (Table II). In addition, Torkildsen's (1936) patient showed a lowered sugar tolerance. Rehbock's (1936) 2 patients who were admitted in coma after brief but intense headache had glycosuria, described as 3 plus. In the second patient there was also acetone in the urine and the blood sugar was 228 milligrams per cent; administration of insulin did not prevent rapid exitus. The information on these cases is meager, but as Table II shows, the symptom seems to range from a fleeting glycosuria with normal blood sugar to severe diabetes mellitus in the case of Byrom and Russell (1932).

This was a woman of 49 years with a strong family history of diabetes and a personal history suggestive of diabetes for 20 years. After 4 days of headache the patient was admitted to hospital in coma with respiratory failure. She showed severe hyperglycemia and ketosis, but failed to respond to insulin and glucose and soon died.

Two months before the fatal coma this patient had been in hospital for diabetic symptoms and at that time her hyperglycemia had been controlled by dieting and 40 units of insulin three times a day. When she came into hospital again, in coma with a high blood sugar and ketosis, it was not unnaturally concluded that the coma was diabetic; but she failed to respond to insulin and glucose. At necropsy there was a typical colloid cyst with considerable hydrocephalus of the lateral and third ventricles. In retrospect the authors point out that absence of any signs of dehydration and a strong tendency to respiratory failure were additional points against a pure diabetic coma. They consider that the patient should have been treated by hypertonic salt to reduce intracranial pressure rather than by the isotonic saline which is ordinarily given in diabetic coma to combat dehydration.

From these cases it is probable that the association of disturbed sugar metabolism with colloid cyst is more than a coincidence.[1] The glycosuria seems in most cases to be transitory, and only at the height of an acute hydrocephalic attack. It may thus be easily overlooked, though it is clearly not invariably present in all acute attacks (e.g., the second attack of coma in Case 5). Glycosuria is not seen with any degree of frequency with other cerebral tumors, or with raised intracranial pressure from other causes, and it must be regarded as an important pointer in diagnosis. In acromegaly to be sure, glycosuria is not infrequent, but this is due to excess of diabetogenic hormone from the eosinophilic ade-

[1]The notes of 2 other unpublished but verified cases have been kindly placed at our disposal. Mr. Douglas Northfield's patient, a woman of 60 years, had glycosuria on 9 of 10 consecutive days while in a state of organic dementia and semicoma. Rothera's test was feebly positive on two occasions. Two blood sugar readings during this period were 320 milligrams and 397 milligrams per cent, respectively. There was no clinical improvement following insulin. At necropsy Professor Dorothy Russell found degeneration and gliosis of the hinder parts of the paraventricular nuclei, with focal loss of the ependymal epithelium in this region and associated gliosis of the subependymal layer.

In Professor Norman Dott's case a woman of 50 years, during a severe attack of headache, had sugar and acetone in her urine; on the same day her blood sugar was 158 milligrams per cent. In previous attacks of headache the urine had not contained sugar.

noma, whereas in colloid cyst the glycosuria is probably due to local involvement of nervous pathways in the neighborhood of the cyst.

Cerebrogenic glycosuria has been known since Claude Bernard produced it experimentally by puncture of the floor of the fourth ventricle. Later experimenters showed that transient hyperglycemia and glycosuria may be induced by stimulation of the hypothalamus; and that in all probability the impulses pass down the brain stem and spinal cord, thence by the splanchnic nerves to the adrenal gland (Ranson and Magoun 1939, p. 125). However, since the hormones of the adrenal cortex can produce glycosuria the possibility that the pathway is from hypothalamus to pituitary, thence to the adrenal gland is by no means ruled out. According to Brouwer (1950), in man glycosuria is very rare with chronic lesions of the hypothalamus, and it is usually due to involvement of the paraventricular nuclei. In animals experimental glycosuria is caused by acute lesions and is essentially transitory; and Long considers it improbable that permanent disturbance of carbohydrate metabolism can be produced by lesions of the hypothalamus.

Our observations are of a transitory glycosuria at the time of acute obstruction of the foramina of Monro by the cyst, and these fit with the views expressed above. At the time of acute obstruction the cyst may be displaced downward (Fig. 4) on to the uppermost nuclei of the hypothalamus which are the paraventricular nuclei (Fig. 11). An alternative explanation would be that the fornix or the medial nucleus of the thalamus contains a considerable concentration of neurones which are concerned with carbohydrate metabolism.

There are also the cases of colloid cyst with true diabetes, but in these the consitutional factor appears to be of paramount importance. In patients without a predisposition to diabetes it seems unlikely that colloid cyst would produce the disease, but in a predisposed person it may precipitate the onset of true diabetes. In discussing a case of glioma of the hypothalamus with diabetes, in a patient with a strong family history of diabetes, Brouwer (1950) states that he doubts the possibility of diabetes mellitus of cerebral origin.

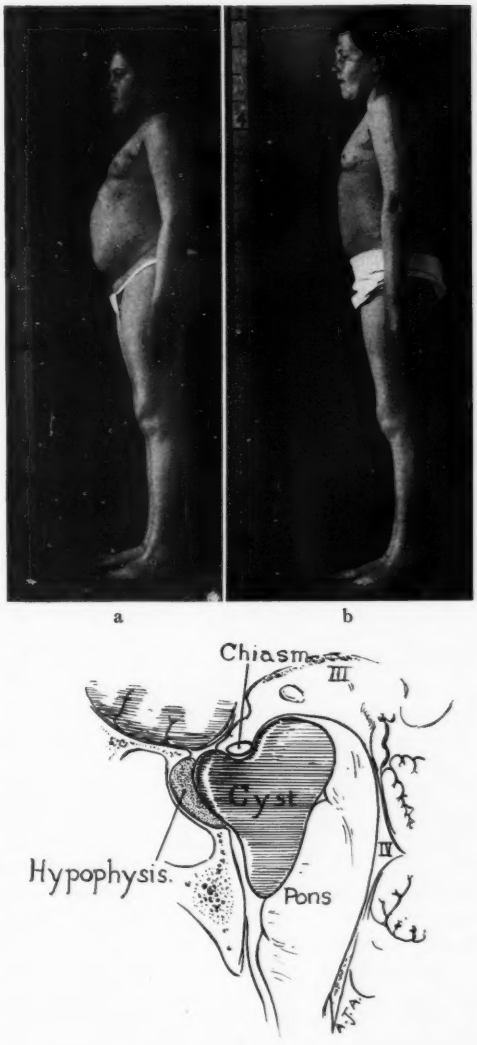


Fig. 10. A case of craniopharyngeal cyst, for comparison with Figure 9. a, The patient immediately before removal of her cyst; b, 1 year later, showing disappearance of most of obesity (which took place without dieting); c, diagram of the cyst which was removed after section of one optic nerve.

In some of our cases the glycosuria appears to have been of the renal type inasmuch as the blood sugar was normal. Hitherto renal glycosuria and glycosuria with hyperglycemia

TABLE II.—GLYCOSURIA WITH COLLOID CYST OF THIRD VENTRICLE[1]

	Age	Sugar		Ketosis	Clinical state	Remarks
		Urine	Blood			
Our Case 12	22	Trace			Headaches. Alert	3 years after operation developed acromegaly. No glycosuria
Our Case 8	34	Trace		No	3 weeks of severe headache. No stupor	Glycosuria for 3 days after operation
Our Case 5	55	3%	0.12%		Coma	Fall of blood and urinary sugar after 20 units of insulin
Byrom and Russell (1932)	49	++	0.32% rising to 0.99%	Yes	Coma following 4 days headache. No dehydration	20 year history of diabetes controlled by insulin. Family history of diabetes. Coma failed to respond to insulin and glucose
Neustaedter and Meltzer (1939)	46	1.4%	Lowered sugar tolerance		4 years of headaches and organic dementia. No coma	
Eskelund (1935)	27	"Some"			3 weeks of intense headache. Sudden coma	
Rehbock (1936) Case 1	43	+++			6 days of headache 3 hours coma	Sudden death
Rehbock (1936) Case 2	45	+++	0.228%	Yes	5 hours of headache and coma	Insulin administered. Sudden death
Stookey (1934) Case 3	31	?positive	Normal		1 year dizzy spells. No coma	On admission "diabetes but . . . normal blood sugar"
Barbu (1936)	43	?positive			No details. Coroner's case	"Diabetes"
Torkildsen (1936)	15		Lowered sugar tolerance		10 months of headache. No coma.	

[1]See footnote in text for 2 additional cases of Mr. Northfield and Professor Dott.

have been regarded as quite separate conditions, but our cases suggest that both renal glycosuria and hyperglycemia may be produced from interference with identical or adjacent neural mechanisms. Further observations are required to confirm our findings, and indeed the whole subject of glycosuria with colloid cysts requires further investigation. The additional information should not be difficult to obtain now that these lesions can be more promptly recognized and more easily treated.

Albuminuria. We can do no more than record that in 1 of our cases (Case 9) and 3 in the literature (Pollock 1915, Torkildsen 1936, Jones and Collins 1934) albumin was found in the urine without any local disturbance, such as urinary infection, to account for it. Whether this is due to lowered renal threshold and neurogenic in origin must await further observations.

Hypersomnia. Excessive sleep was not observed before operation in any of our cases except Case 5; this patient for some months before death had been very lethargic and apt to fall asleep at any time (Riddoch, 1936). Lindon's (1938) Case 3 on one occasion slept for 17 hours, and Jefferson and Jackson's (1939) Case 5 had pronounced hypersomnia for years; Zeitlin and Lichtenstein's first case (1940) had sleeping spells, while their second case had an uncontrollable desire to sleep but could usually be easily roused. Stookey's (1934) Case 3 was very drowsy and would doze off when talking. Sudden attacks of sleep for 36 hours occurred in Fulton and Bailey's case (1929, Case 3) and in the case of Guillain, Bertrand and Périsson (1925); and in the latter case it was practically impossible to rouse the patient.

At operation under local anesthesia in our Case 11, when the cyst was dislodged from the foramina of Monro, the patient fell into a deep sleep from which he could not be roused. In Case 7 the patient went to sleep during operation but could always be roused. On the other hand, 3 others (Cases 8, 9, and 14) stayed awake during the whole operation, 1 of them (Case 9) becoming much more alert than she had been before. We have frequently observed that opening the third ventricle during operation under local anesthesia precipitates an

attack of sleep, whether the approach is through the foramen of Monro or the anterior wall of the third ventricle.

We conclude that pathological sleep may occur independently of acute hydrocephalic attacks, and that it is a sign of disorder at the site of the cyst.

Reproductive functions. There is no evidence of disturbance of menstruation in our own cases or in those in the literature. This is of considerable interest since amenorrhea is not uncommon with hydrocephalus due to cerebellar tumor, presumably as a result of dilatation of the third ventricle and consequent compression of the pituitary gland. Although there may be some dilatation of the third ventricle with colloid cyst (that is to say, distal to the site of obstruction at the foramina of Monro), it is much less than that seen when the obstruction is at the fourth ventricle or aqueduct of Sylvius.

Fertility appeared to be unaffected in our patients, and before operation there was no disturbance of libido which could not be accounted for by general illness. Libido was increased in 1 male patient (Neustaedter and Meltzer, 1939); and after operation in 1 of our patients (Case 17); this was a woman of 41 years who before the onset of her headaches had borne 11 children. Stookey's Case 1 (1934) and the patient of Toennis (1936) were impotent; the latter had underdeveloped genitalia, was a morphine addict, and had "acromegaloid" signs. These are very few cases from over 150 examples of the lesion and the evidence thus suggests no specific disturbance of reproductive functions by colloid cyst.

Other vegetative symptoms. A moderate obesity has been noted in several cases [our Cases 8 and 17, McLean (1936, Case 2), Zeitlin and Lichtenstein (1940, Case 2), Jefferson and Jackson (1939, Case 6), Stookey (1934, Case 3)]. In our Case 8 the obesity was not appreciably modified by removal of the cyst (Fig. 9).

Loss of weight during the course of illness was recorded in 2 cases (Pollock, 1915; Campbell and Schwind, 1938–39).

Polyuria has been briefly mentioned in a few cases (Ross, 1917; Stookey, 1934, Case 3) and our Case 9 after operation showed slight excess of thirst. No cases of diabetes insipidus have so far been encountered.

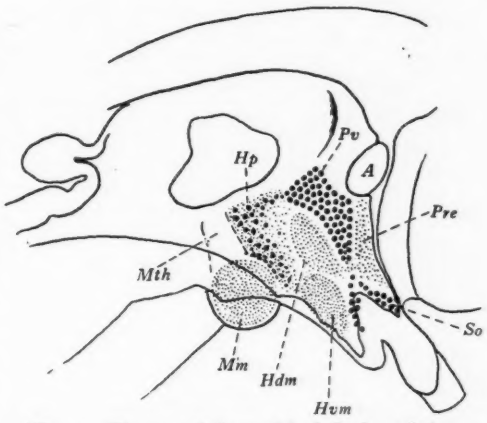


Fig. 11. Diagram of the nuclei of the hypothalamus. *Pv.* Paraventricular nucleus. (From Le Gros Clark, *J. Anat.*, 1936, vol. 70.)

Excessive hunger was observed with attacks of headache in the case of Campbell and Schwind (1938–39). Marked hyperhydrosis occurred in Ectors' case (1941–42) and during the final acute hydrocephalus in our Case 5; this sign is seen with any acute variety of raised intracranial pressure. Exophthalmos was observed by Stookey (1934, Case 3), Dandy (1933, Case 2), and Neustaedter and Meltzer (1939); but this condition also is not uncommon in raised intracranial pressure from any cause and its association with colloid cyst cannot be regarded as significant.

In several of our patients the hemoglobin level and the erythrocyte count in the blood have been high (6 to 7 M.). Unfortunately no hematocrit or blood volume determinations were made. We have not found any reference to similar findings in the literature on colloid cysts, but Barker and Craig (1936) have drawn attention to relative polycythemia with hypophyseal and diencephalic lesions. Their cases suggest a neurogenic influence on the formation of red cells, but there is no pathological verification of the cerebral lesions and their evidence is thus not complete.[1]

The blood pressures in these patients show wide variations.

[1] A. Baserga has observed polycythemia in a patient with a tumor of the hypophyseal stalk. Policlin., 1934, 41: 17-24.

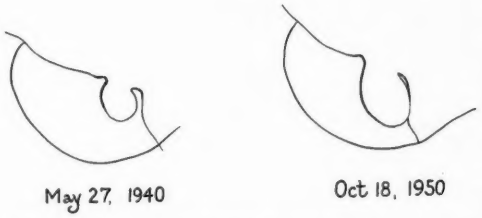


Fig. 12. Case 12. Tracings of the sella turcica. The colloid cyst was removed in February, 1941. In 1944 the patient began to show the appearances of acromegaly and her sella turcica enlarged progressively.

Acromegaly. In the majority of cases no endocrine abnormality of habitus has been noted, but there are in the literature 3 cases in which it was recorded that the patient had acromegalic features (Dandy, 1933, Case 2; Toennis, 1936; and Neustaedter and Meltzer, 1939), and 1 of our own patients developed acromegaly after removal of her colloid cyst.

CASE 12. This patient, a woman of 22 years, had her colloid cyst removed in December, 1940 (q.v.) with complete relief from headache and other symptoms. In June, 1944 her menses, which had previously been regular, ceased and in 1947 her features and extremities were clearly becoming acromegalic. In 1950 her acromegaly was a little more advanced but she was still free from visual symptoms and headache, and remained at work. There had been progressive enlargement of her sella turcica (Fig. 12), and there is hence no reason to doubt that she has an eosinophilic pituitary adenoma.

What the significance of the association of colloid cyst and acromegaly may be must await further experience. It has been suggested that there might be such a condition as neurogenic acromegaly. Proof of this view could only come from full necropsy evidence of acromegaly in a case in which serial sections of the hypophysis fail to show an eosinophilic adenoma.

MENTAL SYMPTOMS

Patients with colloid cysts tend to be temporarily confused during and after a severe attack of headache. In most patients with raised intracranial pressure there is slight dulling of attention and memory independent of the attacks, though in any single patient this may be appreciated only by comparing the preoperative and postoperative state (Case 13). In a certain number of cases there is a progressive dementia of an organic type (e.g., our Cases 5 and 9). This syndrome has been referred to by Riddoch (1936), who pointed out that it may be unaccompanied by headache, vomiting or papilledema, and may thus completely dominate the clinical picture. The cases of Neustaedter and Meltzer (1939), and Larson (1940) were admitted to a mental hospital.

The most common manifestation of this organic dementia is a disturbance of intellect. The patient becomes forgetful, slow, unable to concentrate, and shows loss of insight. In more advanced cases there is disorientation, confusion, and incontinence of urine and feces. Some show emotional instability. The syndrome does not differ materially from that occasionally seen with cerebellar and midbrain tumors producing hydrocephalus, though the incidence of organic dementia is probably higher with colloid cysts than with these more caudally placed tumors: 2 of our 19 cases of colloid cyst showed organic dementia (Cases 5 and 9) and in the 138 cases in the literature we found 10 in which the syndrome was present in some degree. The symptoms may come on slowly through a period of years (Case 5). They may disappear spontaneously during spontaneous recovery from hydrocephalus (Case 9), a fact which supports the usual contention that the symptoms are due to hydrocephalus rather than to local pressure of the cyst. The dementia may clear up completely and permanently after removal of the cyst. Thus, in our Case 9 the patient, a middle-aged housewife, who had been demented for several months, became mentally normal within 3 months of removal of her cyst; and she continued thus, through periods of considerable stress, including the London Blitz and the death of her husband, up to the time when she was last seen 14 years after operation when she was aged 57 years.[1]

The relationship of colloid cysts to psychotic symptoms is a question of considerable interest, partly because the cyst is in contact with, and may compress, the anterior nucleus

[1]Foerster and Gagel's (1933) case of ependymal cyst of the third ventricle, which is not in our opinion a colloid cyst, showed recovery after operation from an even more severe organic dementia.

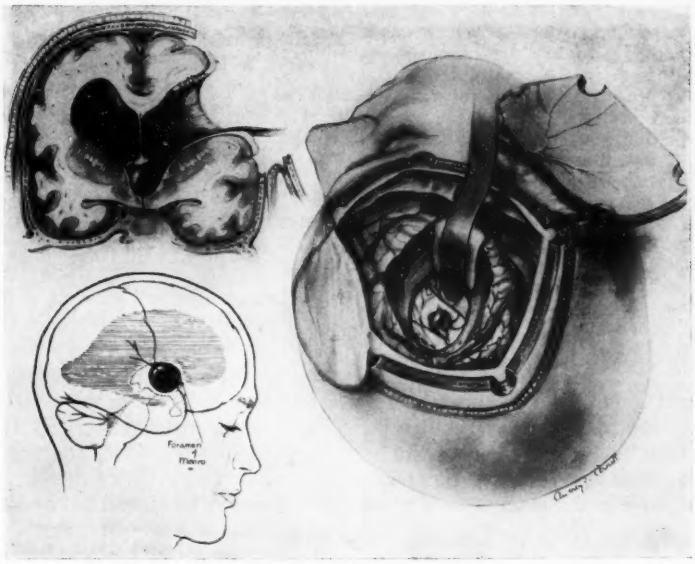


Fig. 13. Case 7. Sketches of operation.

of the thalamus and the fornix, and also because operative removal of the cyst usually involves division of part or whole of one or both anterior columns of the fornix. Papez (1937) has suggested that the fornix and anterior thalamic nuclei, along with the hippocampus, gyrus cinguli and hypothalamus, form circuits which subserve emotional feeling and expression. Is there any evidence from our cases to support this hypothesis?

In the literature on colloid cysts it is not easy to separate the organic dementias from endogenous psychoses because the information is usually so scanty. There are, however, a few cases in which it is clear that a psychotic or psychopathic state existed. Ectors' case (1941–42) showed depression, while Jefferson's (1937) suffered from recurrent depression and delusions of persecution, and these symptoms were still present after the colloid cyst had been removed. In Greenwood's Case 4 (1949) the patient was found to be suffering from psychoneurosis 1 year subsequent to removal of the cyst.

In the following case of our series there was an abnormality of personality which was not improved by removal of the cyst.

CASE 7. This man was operated upon at the age of 40 years. In order to remove the cyst, part of the right frontal lobe was removed and an incision 0.7 centimeter long was made from the upper margin of the foramen of Monro into the anterior columns of the fornix.

There was a history of insanity on both sides of this man's family and his siblings were of low intelligence. Throughout his life he had been occasionally incontinent of urine and in adult life he showed violent outbursts of temper, "minor frenzies" with a suggestion of aggression in his attitude. Otherwise he was of reliable and moderate habits.

The symptoms of colloid cyst had been present for 7 years before operation. They consisted of attacks of numbness and sometimes of weakness of the right limbs and right side of the trunk, sometimes with loss of consciousness, headaches, and failure of vision. Papilledema was present for at least 6 years before operation, but he refused to go to hospital until he was almost blind. It seemed as though his tempers were damped by the symptoms of raised intracranial pressure.

After the cyst was removed in 1935 he was at first confused and disorientated and had some fits. Within a few weeks these symptoms disappeared, but he did not recover his sight. He never worked again and made no attempt to learn Braille.

For 1 year after operation he remained apathetic. As the apathy faded his outbursts of temper became much worse than they had ever been before and at times he violently attacked his wife and threatened to kill her. In 1937 we examined him again: he was

polite and affable in the ward, his memory was good, and there were no organic neurological signs apart from bilateral optic atrophy. Ventriculography showed slight reduction in the size of the lateral ventricles since the preoperative ventriculogram, and there was no recurrence of the tumor (Fig. 4). By 1938 he had become unmanageable and was admitted to a mental hospital for some months on account of his homicidal tendencies during his tempers. Thereafter his attacks of temper became less severe and by 1950, though still subject to outbursts of violent temper in his own home, he was no longer aggressive, and he always behaved well in public. His personality remained well preserved, though somewhat flat and apathetic: he was intelligent, and physically very well. He had had no fits since one after ventriculography in 1937.

This man had a family history of mental disease and his own history indicates that he was constitutionally liable to outbursts of temper and aggression. With this there was probably associated a tendency to epilepsy. With the development of hydrocephalus from his colloid cyst he became almost blind and for the time his emotional outbursts were less in evidence. During the 5 years after the removal of his colloid cyst, as his alertness and his physical state improved his fits of temper became violent and homicidal. In the next 10 years his outbursts, though still frequent, were more controlled and this improvement coincided with a change of environment and the intervention of his son who was now old enough to assist in looking after him.

The postoperative symptoms in this case conform with the patient's personality before he developed symptoms of colloid cyst. To us they seem the reaction of the patient to illness and not the result of partial division of the fornix. There is no evidence that any of the psychological symptoms were due to the presence of the cyst or to brain injury during its removal.

From the small amount of information which is available it appears that the relationship of colloid cysts and endogenous psychoses and psychopathic states is probably fortuitous. The psychotic symptoms varied from patient to patient. They do not appear to have been precipitated by development of the cyst. They were not improved by removal of the cyst, a procedure which usually entails incision into the anterior columns of the fornix as well as incision or excision of part of one frontal lobe. Any worsening of symptoms which followed removal of the cyst could probably be accounted for by increased physical activity resulting from relief of raised intracranial pressure.

As the section on late results will show we have 8 other patients who have survived removal of a colloid cyst. None of these showed disorder of personality before operation, apart from organic dementia. At operation each had removal of 20 to 30 grams of right frontal lobe and partial or complete division of the anterior columns of the fornix. After operation all returned to their work, and with one exception (Case 7) showed no disturbance of emotion or intelligence. So far as they go these preliminary inquiries suggest that pressure upon the anterior tubercles of the thalami, and pressure on, or partial or complete section of, the fornix have no permanent effect upon personality.

Whether immediately after operation there are transitory effects from incision of the fornix is difficult to determine with our present methods, because of the presence at that time of symptoms due to the recent acute rise of intracranial pressure, blood in the ventricles, and so on. But some patients go through the postoperative period without any obvious changes of their emotional state.

Operative Treatment

We have removed 11 colloid cysts, with 2 fatalities, and have 2 patients in whom the cyst, outlined by ventriculography, has been treated by a preliminary right frontal decompression and there has been as yet no occasion to remove the cyst. We believe that operation should be proceeded with immediately the ventriculographic diagnosis has been made; that is to say, on the same day.

It has been suggested that since the cyst only produces serious symptoms by blocking the foramina of Monro, it might be left where it is, and all that is necessary is to by-pass the obstruction by the ventriculocisternostomy of Torkildsen (1948). Such shortcircuiting operations have been a great boon in irremovable tumors of the third ventricle and midbrain, and they may work satisfactorily

in colloid cysts. But Bull and Sutton (1949) mention a case in which after ventriculocisternostomy the colloid cyst was subsequently removed. And the same and other authors report deaths after subtentorial decompression. Moreover, operative removal of the cyst is not difficult and the results are very satisfactory. For these reasons we favor a direct operative attack upon the cyst.

The approach developed by Dandy between 1922 and 1932 was through the right frontal lobe and anterior horn of the lateral ventricle, with division of as much of the anterior pillars of the fornix as is necessary to expose the cyst freely, and this has proved simple and satisfactory in our hands (Figs. 7, 8, 13). In the majority of cases the cyst can be dissected from the choroid plexuses without risk of serious hemorrhage. However, the cyst wall is sometimes firmly adherent to the choroid plexuses, and in attempting to remove it serious bleeding has been reported by several authors; and at necropsy blood clot in the aqueduct of Sylvius has been observed in a number of cases. Once serious bleeding from the choroid plexus has been started there is risk of further bleeding from catching the choroid plexus in the sucker; there is also the risk of damage to the ventricular walls from pressure of cotton wool pledgets; and also inevitably retraction of the head of the caudate nucleus becomes more heavy than it should be. Subsequently stenosis of the aqueduct of Sylvius may develop (McLean, 1936, Case 2). Hence, when the cyst wall is firmly adherent to the choroid plexus we prefer not to attempt to remove it. The cyst is emptied and the thin capsule is treated with diathermy. It shrivels up into a tiny bead of burned tissue 2 to 3 millimeters in diameter, leaving the foramina of Monro wide open and unlikely ever again to become blocked. We have done this in 3 cases with survival periods up to 14 years without recurrence of symptoms. This procedure obviates the risk of serious intraventricular hemorrhage. We have also used the same method in 1 case in which the cyst capsule was so fragile that although not adherent it could not be removed.

Busch (1944) has devised another approach through the roof of the third ventricle after excision of part of one frontal lobe. With this exposure he found that the attachment of the colloid cyst to the choroid plexus could be clipped and divided without pulling upon the delicate structures.

Removal of a colloid cyst is in fact usually an easy operation. Provided the surgeon is prepared to be cautious with an adherent cyst wall, difficulties arise only when the anterior horn of the lateral ventricle is not greatly dilated. Then the distance from frontal cortex to ventricular wall is over 4 centimeters and the surgeon is working in a deep hole, in which it may be necessary to retract the head of the caudate nucleus firmly to obtain a good exposure of the foramen of Monro. In that event there is risk of a stormy postoperative course.[1]

CASE 17. D. P., a female, aged 41 years, with 11 children. In this case ventriculograms showed that the lateral ventricles were still relatively small. The colloid cyst was removed without difficulty, but the head of the caudate nucleus was bruised by the retractor and bleeding points on it had to be stopped with stamps of fibrin foam. The whole operation was bloody and as a precaution against postoperative bleeding and hydrocephalus a polythene tube was left in the opposite (left) lateral ventricle for 3 days after operation.

This patient remained very drowsy for 1 week after operation and mentally slow for several weeks. She resumed her housework 5 months after operation and managed fairly well, though somewhat forgetful. Eighteen months after operation she was working regularly, but was still forgetful, at times irritable and also sexually more active than she had been before her illness. There was no tremor, weakness, or ataxia of her limbs, but she complained at times of feelings of unsteadiness.

We have come to the view that when the lateral ventricles are still small it is best to follow Cushing's two-stage procedure. A right frontal flap is turned and the dura is opened; then, without any further interference the wound is closed. This frontal decompression enables the anterior horn of the right lateral ventricle to dilate more than the rest of the ventricular system (Fig. 14), and thus to render the removal of the cyst at a second opera-

[1]It is in all cases advisable to protect the surface of the lateral wall of the ventricle from the retractor with a thin strip of sheet gutta percha on top of which a sheet of lintine is placed. When unprotected lintine or cotton is placed against the ventricular wall shreds of it may subsequently be left behind and set up a fatal ventriculitis. A similar reaction in the subarachnoid space has been reported by Mayfield and German (1943).

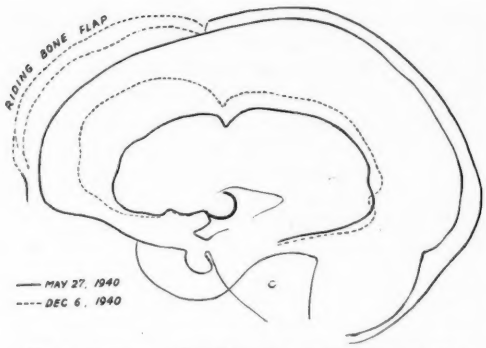


Fig. 14. Case 12. Superimposed ventriculographic tracings showing disproportionate dilatation of the right anterior horn following right frontal decompression.

tion less dangerous, and less injurious to the caudate nucleus than it otherwise might be.

CASE 12. A laundress, aged 22 years, was admitted to the Radcliffe Infirmary, in May, 1940, complaining of attacks of headache of steadily increasing severity for 1 year. She had bilateral papilledema (2D) with normal visual acuity, and no definite localizing signs. At ventriculography both ventricles were dilated; 100 cubic centimeters of cerebrospinal fluid were collected and replaced by air; each ventricle seemed to fill and empty independently. The films showed a filling defect corresponding to a colloid cyst of the third ventricle, but the lateral ventricles were relatively small (Fig. 14). Accordingly, on May 27, 1940, a right frontal osteoplastic flap was reflected, the dura was opened on three sides of the square, and then everything was put back into place without closure of the dura.

There was prompt relief of her headaches and within 6 weeks her papilledema had subsided. She returned to work, but attended hospital as an outpatient.

In October, 1940, the optic discs began to swell again, without recurrence of headaches or other symptoms, and the frontal decompression became tense. This state persisted and she was readmitted to hospital in December, 1940. Air replacement of ventricular cerebrospinal fluid this time yielded 140 cubic centimeters of cerebrospinal fluid and the ventriculograms showed increased hydrocephalus with excessive dilatation of the anterior horn of the right lateral ventricle into the area of brain which had been decompressed (Fig. 14). On the same day, Mr. Pennybacker re-elevated the right frontal flap without difficulty and, after resection of a cone of frontal cortex and white matter down to the ventricle, removed the colloid cyst through the dilated right frontal horn. The whole procedure was bloodless.

Convalescence was uneventful and the patient went home 2 weeks after operation. She returned to work 6 weeks later at which time her optic discs and visual acuity were normal. She remained well and at work, up to the time when she was last seen in October, 1950, but in the last 6 years of this period of observation she was developing acromegaly, as has already been described.

Although Stookey (1934) considers it dangerous, this two-stage method of dealing with the colloid cyst when the lateral ventricles are still relatively small appears to us safer than a one-stage procedure in which it is necessary to retract the head of the caudate nucleus strongly in order to expose the tumor. At the first operation the dura should be opened about 1.5 centimeters from the margin of the bone, to avoid damage to the cortex of the brain during the subsequent re-elevation. It is also useful to cover the dural gaps with strips of fibrin film or sheet gutta percha; these should be about 2 centimeters wide as eventually with the bulging of the decompression the cut edges of the dura gape 1.5 centimeters or more. Strips of gutta percha may also be inserted between the cut edges of the bone to prevent them from uniting.

In some cases papilledema may be slow to subside after the frontal decompression. Thus, in a girl of 19 years (Case 18) with papilledema of 4 diopters, 6/6 vision, and relatively small ventricles, it was over a year before the optic discs became completely flat; during this time the patient was free from symptoms and working regularly as a clerk, and her visual acuity remained normal. When vision is already in jeopardy a two-stage operation would be inadvisable; but in such cases the ventricles are usually so dilated that the need for a two-stage operation does not arise.

There are 2 cases in our series in whom after a first-stage frontal decompression, respectively 3 years and 2 years ago, the patients have remained well and there has been no indication to reoperate and remove the cyst. In both of these patients the ventriculographic diagnosis of colloid cyst is reasonably definite. It may be noted also that in Case 13, symptoms were relieved for 4 years after a subtemporal decompression, but then headache and papilledema recurred. In 1 other case (Case 6) subtemporal decompression followed by x-ray treatment was given owing to an error of diagnosis, on the supposition that there

was a deep left temporal glioma. Improvement followed this treatment but the patient died 4 years later from radiation necrosis of the brain (Pennybacker and Russell, 1948, Case 2).

OPERATIVE MORTALITY

Ventriculography which is not immediately followed by operative removal of the cyst, or in appropriate cases by a first-stage decompression, is a potent cause of death. This is not to be wondered at, since in the past, without any aggravation of the high intracranial pressure by air injection, 1 in every 5 patients has died suddenly from acute hydrocephalus. One of our patients (Case 14) became cyanosed on the x-ray table after ventriculography and his ventricle had to be tapped immediately.

Of the 11 patients from whom we have removed a colloid cyst 2 died: Case 10 from infection with a gram-negative bacillus probably present in the saline solution used at operation: Case 14 suddenly 12 hours after operation, from unexplained coma and respiratory failure.

In the literature, of some 60 odd cases in which the cyst was removed one-third died. Bleeding at the time of operation from the choroid plexus or vena terminalis appears to have been the most common cause of death, and at necropsy clot was found blocking the aqueduct of Sylvius in at least 2 cases (Greenwood, 1949, Case 5; Dandy, 1933, Case 4). It might be possible to save such cases as these by leaving a polythene tube in the lateral ventricle for several days after operation, as was done in Case 17.

Another cause of death was "aseptic meningitis" (Ectors, 1941–42). Apart from lintine ventriculitis, already mentioned, we believe that postoperative inflammatory states are usually due to bacterial infection which may be of such low grade that the bacteria, often of the so-called "nonpathogenic" variety, may elude discovery unless special methods of cultivation are carried out. The ventricles of the brain are particularly vulnerable to infection by all manner of organisms which would not be harmful in other parts of the body. With modern antibiotics the risk of this complication has been greatly reduced (Pennybacker, Taylor, and Cairns, 1947).

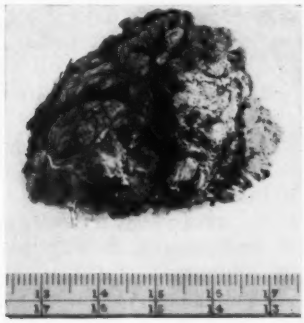


Fig. 15. Case 7. Showing the amount of frontal lobe tissue excised in the operative approach to the colloid cyst.

POSTOPERATIVE COMPLICATIONS

Early. Now that diagnosis and operative treatment of these lesions have become a matter of common experience most cases pursue a course free from serious complications. However, in the first days after operation certain symptoms may be observed.

Although the part of the frontal lobe which is excised lies in front of area 4 and usually also in front of area 6, slight contralateral hemiparesis with conjugate deviation of the eyeballs toward the side of the lesion may be observed during the first 24 hours or more. Sometimes this is evident only in the spontaneous movements which the patient makes while he is coming round from his anesthetic; when he is conscious enough to carry out voluntary movements on command the weakness is as a rule no longer apparent. In other cases the temporary weakness is more obvious, and of longer duration. In all our cases recovery was complete. This hemiparesis is evidence that movement of the contralateral half of the body is subserved by a much wider area of frontal cortex than the excitable motor cortex, and its temporary character indicates the power of the brain to compensate for loss of certain parts of its cortex.

In a certain number of cases the patient is drowsy, confused, irrational, and incontinent for some days after operation, as noted by Greenwood (1949). With this there is usually loss of memory of the whole period in question, and sometimes temporary loss of memorizing for a short period afterward. One of our pa-

tients was mute for some days (Case 11), and a similar experience was recorded by McLean (1936). These symptoms may be due to blood, Ringer's solution, or some other irritant substance in the ventricular system. Similar symptoms may follow ventriculography in any case of chronic hydrocephalus. Spontaneous recovery is the rule, though in a few of the colloid cyst cases recovery has been protracted and associated with high intraventricular pressure and obstruction of the aqueduct of Sylvius by a fragment of clot.

If the region of the caudate nucleus is damaged by retraction, hemiparesis and drowsiness may persist for days or even weeks (Case 17). One of Kessel and Olivecrona's (1936–37) patients in whom there was bleeding in the region of the caudate nucleus had a peculiar hypermotility of the ipsolateral upper limb.

Convulsions in the first fortnight after operation occurred in 2 of the 9 survivors of our series (Cases 7 and 8), also in several cases reported in the literature. Such fits are not uncommon after cortical excisions or division of cortical veins, and do not necessarily indicate that there will be fits at a later stage.

Late. Three of our 9 patients had an occasional fit. Case 13 had two fits in the first year after operation, then no more in the ensuing 7 years. In Case 7, the patient who had had fits before operation, had one following a ventriculogram 2 years after removal of his cyst and no more in the next 13 years. In Case 17 the patient had one fit 8 months after operation, then no more in the ensuing 12 months of observation. Similar experiences are reported in the literature, but as in our cases the liability to epilepsy appears to have been mild. In our cases it has not interfered seriously with the patients' working capacity.

Late Results

The 9 survivors of operative removal of the cyst in our series have been followed for up to 15½ years. All have been relieved of their preoperative headaches and visual symptoms, except that in Case 7 the patient, who already had severe optic atrophy, had no recovery of his sight. Four of the 5 young women have married since the cyst was removed and are doing normal housework; three of them have borne children. The other young woman is in regular work as a clerk, and is free from complaints; but she is developing acromegaly. Two older women who were married when they came for treatment are also doing their housework. One of them made a quick and complete recovery from a severe organic dementia which was present before operation (Case 9). The other (Case 17), the mother of 11 children shows, 18 months after removal of her cyst, slight impairment of memory and quickness of temper together with heightened libido as compared with her premorbid state. This was the patient in whom the lateral ventricles were relatively small and there was some damage to the right caudate nucleus at the time of removal of the cyst. Of the 2 men, 1 is working regularly as a policeman (Case 16); the other has remained almost blind since before operation, has not worked, and has continued to show outbursts of violent temper which were present before he fell ill (Case 7). This is the only unsatisfactory result among the survivors.

In 1 patient (Case 7) ventriculography 2 years after removal of the cyst showed a slight reduction in the size of the lateral ventricles as compared with the preoperative pictures. Although this patient, and presumably the other 8, have considerable residual hydrocephalus, there is no impairment of intelligence.

The sense of smell was examined in 6 patients after operation and has been found unaffected in all, except for relative anosmia at the right nostril in Case 7. This confirms experimental evidence that impulses subserving smell are not conducted by the fornix.

Of the 3 patients treated by decompression alone, 1 was well for 3 years but died subsequently of radiation necrosis of the brain (Pennybacker and Russell, 1948, Case 2). The 2 others are in full work 2 and 3 years after decompression; one of them, a young woman, has married since her decompression and has had a child.

Summary

1. Nineteen cases of colloid cyst of the third ventricle are described. Most of the symptoms are due to hydrocephalus and

there is great variation in the clinical picture depending on the acuteness of the obstruction of the foramina of Monro. The picture varies from acute and rapidly fatal headache to chronic organic dementia without headache. Intermission of symptoms for periods of up to 10 years occurred in about half of our cases.

2. Ventriculograms before and after removal of the cyst in 1 case showed that when the cyst blocks the foramina of Monro the anterior part of the third ventricle is displaced downward. In addition the cyst may impinge upon the upper (ventral) part of the hypothalamus.

3. During the acute hydrocephalic attacks sugar is found in the urine in a significant proportion of the cases. The blood sugar may be normal or raised. This suggests that central nervous pathways influencing sugar metabolism and those which influence the renal threshold for sugar are situated in the same part of the brain. From experimental evidence the part of the brain involved is probably the nucleus paraventricularis of the hypothalamus.

4. Other neurohumoral mechanisms may occasionally be disturbed by local pressure of the cyst. A few patients have shown hypersomnia, one has developed acromegaly since removal of her cyst.

5. Transventricular removal of the cyst, after incision of the anterior columns of the fornix, as elaborated by Dandy, is the treatment of choice. The main danger is hemorrhage into the ventricles when the cyst is firmly adherent to the choroid plexuses; in such cases it may be safer and equally effective to empty the cyst and destroy its capsule with diathermy. When the ventricles are still relatively small the safer course may be to deal with the cyst by a two-stage operation.

6. The cyst was removed in 11 of our cases with 2 deaths. In 8 of the 9 survivors all symptoms were relieved, including organic dementia. Recovery of full working capacity was usually prompt. There was no evidence that operative injury to the frontal lobe and the fornix produced any emotional or intellectual changes, or impairment of smell.

7. After operation ventriculograms in 1 case showed slight reduction in size of the lateral ventricles, but the degree of hydrocephalus which persisted was considerable.

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RECONSTRUCTION OF THE COMMON BILE DUCT WITH A FREE URETERAL GRAFT

An Experimental Study

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REPAIRING or reconstructing the common bile duct in cases of injury or stricture taxes the ingenuity of all concerned with this problem. The ideal repair of a missing section of common bile duct is mobilization of the divided ends with primary anastomosis over a T-tube. This method uniformly gives the best results because the flow of bile is re-established through its normal channel, the common bile duct, and probably because the sphincter of Oddi is left intact. Unfortunately, this method of repair is not always technically possible even though the distal end of the common duct is mobilized out of the head of the pancreas and brought to the hilum of the liver. On occasion there may still be a gap to bridge. In such instances the usual procedure is to anastomose the jejunum to the hepatic duct. Hepaticojejunostomy frequently gives early gratifying results, but all too often after several months a stricture may form at the anastomosis, necessitating a further surgical procedure. Thus on occasion there is a need for some structure to bridge satisfactorily a gap in the common bile duct.

Inert tubes made of rubber, vitallium, polyethylene, and silicon (bouncing clay) have been used for this purpose with little success. Experimentally, in dogs, other tissues and organs have been substituted for missing sections of common bile duct. Lord and Chenoweth used free grafts of fascia, vein, and peritoneum. The grafts were fashioned around vitallium tubes and anastomosed to the divided ends of the common duct. The results were variable. The free fascia grafts proved most successful. In this group the grafts remained patent without stricture, but there was no epithelization of the inner lining of the graft. Venous grafts were moderately successful, but in 40 per cent of the animals there was bile leakage or stricture formation. Some of the venous grafts showed epithelization. The peritoneal grafts were least successful.

Another method of constructing a bile passage in the dog was tried by McCorriston and MacKenzie. These investigators fashioned a split thickness skin graft around a lucite rod and buried the constructed tube in the greater omentum. At a later date the skin-lined tube in the free edge of omentum was grafted to the gall bladder and jejunum. The common duct was tied close to the duodenum. One dog lived 24 days, became jaundiced, and died. There was stricture but no evidence of leakage.

It seems reasonable that if a tissue or organ is to replace a section of common bile duct successfully, two factors must be fulfilled. First, the organ or tissue grafted must be transplanted with its blood supply intact, or if grafted free, must easily develop a new blood supply from the recipient site. Second, the organ substituting for the bile duct must be epithelized with an epithelium that will tolerate bile so that stricture does not occur. It was thought that perhaps the ureter would fulfill these requirements. Both structures have an epithelial lining. The common bile duct is lined with simple columnar epithelium and the ureter with stratified squamous epithelium. In both cases, the epithelium is subjected normally to changes of hydrogen ion concentration and to precipitation and crystal formation relative to bile and urine. Furthermore, it was thought that perhaps a section of ureter could be brought into position as a graft with its blood supply intact. Even though a

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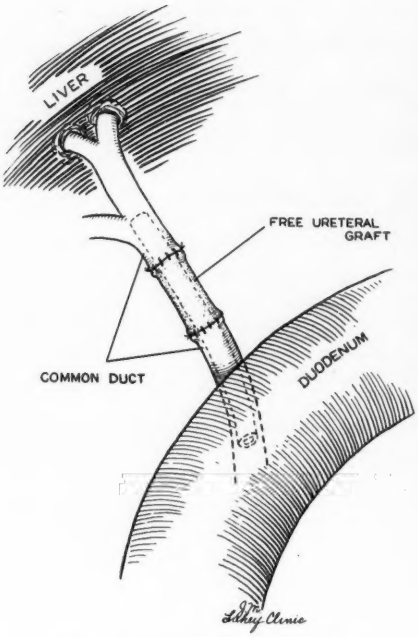

Fig. 1. Diagram showing ureteral graft.

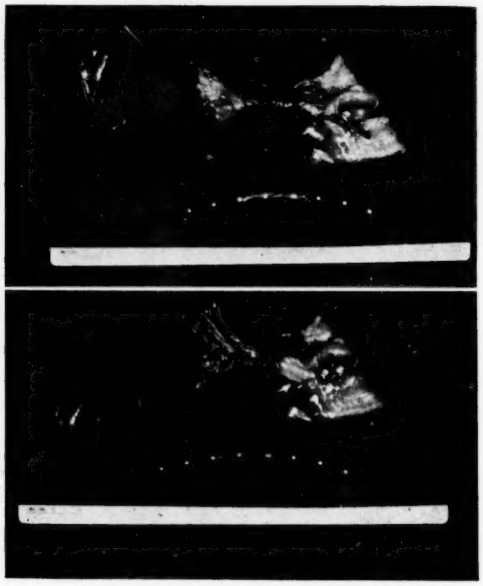

Fig. 2. Above, Catheter is shown passing through the right and left hepatic ducts and ureteral graft into the duodenum. Dog was sacrificed 14 months after operation. Below, Same as above, showing lumen of ducts.

kidney had to be sacrificed if ureter could be used successfully to bridge a gap of common bile duct, the price of nephrectomy would not be too high. With these thoughts in mind, the following experiment was attempted.

PROCEDURE

The following procedure was performed on 7 dogs. Mongrel dogs were anesthetized with intravenous nembutal. In 3 of the dogs endotracheal tubes were inserted and the animals were placed on automatic artificial pressure respiration. In dogs so intubated a combined thoracoabdominal incision was used. As the anesthesia was not satisfactory, this method was abandoned and in the remainder of the dogs an exploratory operation was done through a long curved right subcostal incision. Right nephrectomy was performed and a section of ureter about 2 to 3 centimeters in length was saved close to the pelvis of the kidney. The distal ureter was ligated. The common duct was mobilized and a section excised close to the duodenum. The excised section of common duct was replaced with the segment of ureter removed for this purpose. A short piece of No. 6 ureteral catheter was used as a stent in the ureter and common bile duct. The two anastomoses were performed with interrupted sutures of No. 000000 Deknatel arterial silk (Fig. 1). The abdomen was closed in layers in the usual manner. In 1 dog the same procedure was performed except that a stent was not used. This dog died the eleventh postoperative day, at which time an external biliary fistula had formed.

RESULTS

Three dogs survived the procedure and early postoperative complications so that they were of value for this study. These dogs were sacrificed or died from unrelated causes 3 months, 7 months, and 14 months, respectively, after operation. Clinical signs of biliary obstruction did not develop in any of these dogs. Autopsy revealed the grafts to be intact and patent (Fig. 2). In

all cases the entire biliary tract proximal to the grafts was greatly dilated. The liver in all cases appeared grossly and microscopically negative. The ureteral graft grossly appeared somewhat shrunken and constricted as compared to the dilated biliary tree. Microscopically the ureteral graft showed that the entire epithelial lining of the graft was absent and replaced by fibrosis.

SUMMARY

An attempt was made in the dog to bridge a gap in the common bile duct with a free ureteral graft.

This procedure was accomplished satisfactorily in 3 dogs. The dogs lived 3 months, 7 months, and 14 months, respectively, after operation without clinical evidence of biliary obstruction.

Postmortem examination of these dogs revealed the grafts to be patent. The entire biliary tree proximal to the grafts was markedly dilated, however, indicative of biliary obstruction.

The epithelial lining of the free ureteral grafts was destroyed and replaced by fibrous tissue.

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PIGMENTED VILLONODULAR SYNOVITIS

A Report of Seven Cases

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IN 1941, Jaffe, Lichtenstein, and Sutro described a lesion which they called pigmented villonodular synovitis, bursitis, and tenosynovitis. Following detailed microscopic study of the evolution of the lesion in its various phases, they have designated it as inflammatory in type although a specific agent cannot be determined. It is their opinion that the polyhedral stromal cells are potential or actual macrophages and that they are not true tumor cells in an oncologic sense.

The etiology and nature of the lesion is controversial, and many theories have been promulgated. Several writers have described it as a true tumor, as will be noted by the titles—xanthoma, giant cell tumor, and polymorphous cell tumor. These titles are derived from the presence of foam cells, giant cells, and pigmented cells present in greater or lesser abundance in the lesion. We do not believe these cells are true tumor cells but, rather, that they represent the prolification of undifferentiated connective tissue cells of the synovial membrane.

Galloway and associates classified these lesions in the primary xanthomatoses group and stated that they should be called "xanthoma of the tendon sheaths and synovial membranes."

The theory that the condition represents an inflammatory response to local cholesterol imbalance has been suggested by various writers on the basis of the accumulation of lipoid in the lesions. This finding does not indicate, however, that the cholesterol defect acts as the causative factor and, as is well known, deposits of lipoid are frequently found at the site of inflammations and in tumors. In these instances cholesterol imbalance is not the causative agent.

An inflammatory reaction in response to repeated local hemorrhage has been suggested as a possible etiologic factor. The experimental work of Jaffe and Lichtenstein and others has shown, however, that repeated local hemorrhage either as a result of trauma, the effects of hemophilia, or the effects of the injection of blood into joints fails to produce the histologic picture seen in pigmented nodular synovitis.

PATHOLOGY

The involvement of the synovia may be circumscribed or diffuse. The affected membrane in the circumscribed form shows one or more firm, yellow-brown, sessile or stalked, nodular growths. There is considerable variation in the gross appearance of the lesion in the diffuse form. The synovial membrane is usually reddish-brown in color with scattered areas of yellowish-brown pigment. The villi are long and thin and tend to intermingle. An occasional firm, rounded nodule can be noted.

The tendon sheath lesions tend to resemble the localized stalk lesions seen in the synovial membrane. As a rule, the tendon sheath lesions show a greater tendency toward fibrosis and hyalinization than do the typical synovial lesions, and also tend to be less vascular. There appears to be a high content of lipoid. In long standing cases there may be erosion of the adjacent bone.

Microscopic examination of the lesion from either the tendon sheaths or the synovial membrane of joints presents a basically similar cytologic pattern. The most consistent cellular elements are roundish or polyhedral cells scattered through which may be found foam cells, giant cells, pigmented cells, and fibrous tissue with scattered areas of hyalinization.

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These elements may be present in varying proportion throughout various microscopic fields.

ROENTGENOLOGIC APPEARANCE

Raymond Lewis in 1947 clearly described the x-ray appearance of the lesion as it occurs in the knee joint, giving the following characteristics: "Bones of a young adult; monarticular involvement; excessive amount of synovitis, which may appear smooth in outline and homogeneous in density, but is particularly diagnostic when it is, in part at least, nodular in outline and density, as is frequently the case; joint spacing symmetrical and normal, giving no indication of cartilage abnormality; completely normal appearing bones, without even osteoporosis; no evidence of thigh or leg atrophy."

Lewis stresses the fact that, in the x-ray diagnosis, synovial sarcoma must be kept in mind, particularly when any one of the following three roentgenographic features is present: first, the presence of a nodular soft tissue mass or masses in part or wholly outside the joint capsule; second, the presence of scattered and irregular deposits of amorphous lime within the soft tissue masses; third, the invasion of bone by the soft tissue masses.

This report presents 7 cases of pigmented nodular synovitis occurring in various synovial sites, such as the knee, finger, and ankle. Those cases showing knee involvement presented the typical history and clinical findings described by Lewis in 1947. All the patients were young adults and all had a rather long history of knee swelling, of from one to several years, without a history of definite trauma. There were no specific etiologic factors that we were able to discern. Physical examination of the involved knee presented no evidence of abnormality other than swelling. There was a slight decrease in motion of the involved joint due to swelling and distention of the capsule. There was no fever and the laboratory findings were entirely normal, although Lewis has reported an occasional increase in sedimentation rate.

CASE 1. M. K., aged 29 years, entered Wesley Memorial Hospital on August 14, 1946, with complaints of a swelling beneath the left lateral malleolus. This was first noted 4 or 5 years previously as a firm mass which gradually increased in size. An excision had been done 3 years before admission to this hospital. There had been intermittent pain which was never incapacitating.

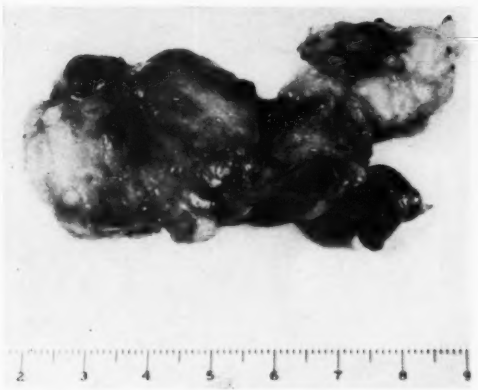


Fig. 1. Case 1. Yellowish-brown firm nodular mass excised from the lateral aspect of the left ankle. The peroneal tendon sheaths were not involved, and at operation this mass could be seen extending into the sinus tarsi.

Examination revealed a firm mass immediately distal to the left lateral malleolus, measuring about 1.5 inches in diameter. The mass was slightly movable and nontender. The peroneal tendons functioned freely and appeared to be independent of the mass. Laboratory studies including blood cholesterol were entirely within normal limits. At operation on August 19, 1946, a firm encapsulated brownish-yellow mass was found, extending posteriorly to the flexor hallucis longus and projecting anteriorly into the sinus tarsi. It was not adherent to the peronei. Microscopic diagnosis showed the findings typical of villonodular synovitis.

Fig. 2. Case 2. Diffuse synovial lesion from anterior compartment of the knee showing a glistening heavily matted yellowish-brown lesion. Occasional firm nodular masses can be seen.

Fig. 3. Photomicrograph of a section taken from a case of pigmented villonodular synovitis. The general topography of the pathologic synovial membrane is well shown. The densely compact polyhedral stromal cells are abundant. Cleft-like spaces are well visualized and the villi are lined by synovial cells × 150.

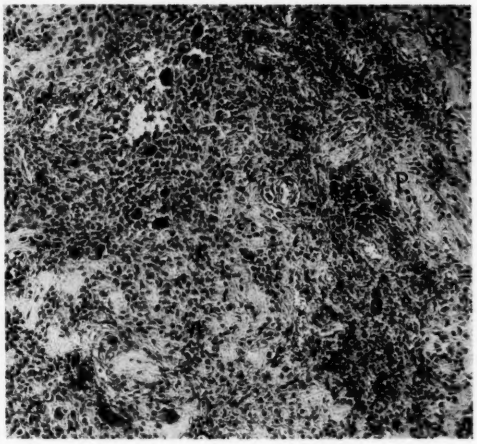


Fig. 4. Photomicrograph showing cellular details, especially the compact stromal cells. In some areas dense granules of hemosiderin pigment are present within the stromal cells. *P*, Pigment × 300.

Because the previous operation had been performed elsewhere we were unable to determine whether the mass had been incompletely excised at that time, or had been completely excised and had recurred. At the time of operation, we could not specifically determine whether an adventitious bursa existed in the region of the sinus tarsi or whether the mass originated from the capsule of the subtalar joint. The tendon sheaths of the peroneal tendons were not involved in the pathologic process. In the 4 years since surgery there has been no evidence of recurrence of the mass, nor any disability about the ankle joint or subtalar joint.

CASE 2. J. P., aged 44 years, entered Wesley Memorial Hospital on May 13, 1946, with a history of intermittent swelling of the left knee for the past 4½ years. There had been no limitation of motion or instability of the knee. He had had occasional episodes of pain along the anteromedial aspect of the knee after prolonged periods of exercise or weight bearing. There was no history of trauma.

Examination showed marked boggy swelling of the left knee. Extension was to 180 degrees, flexion to 70 degrees. There was moderate tenderness over the anteromedial aspect of the joint line. A firm pea-sized nodule could be palpated at the anterolateral aspect of the knee, moderately tender to pressure. Quadriceps tone was good, but there was one-half inch atrophy as compared to the opposite side. The sedimentation rate and serology test findings were normal. Aspiration of the knee joint revealed a blood-tinged synovial fluid, the chemistry of which was entirely normal; the cholesterol of the fluid was within normal limits.

A preoperative diagnosis of pigmented villonodular synovitis was made, and on October 5, 1946, a synovectomy was performed. The synovial membrane was markedly discolored with areas of brownish nodular masses. The knee was filled with about 300 cubic centimeters of blood-tinged fluid. The synovia was removed from the anterior compartment but not from the posterior compartment. The microscopic findings were characteristic of villonodular synovitis. Recovery was uneventful and on November 1, 1946, x-ray therapy was started, 1814 roentgens being administered to the anterior and posterior compartments of the knee in divided doses given over a period of 12 days. After 4 years there has been no evidence of recurrence and the range of motion is 180 degrees of extension and 85 degrees of flexion.

This case is remarkable in that the condition was slowly progressive over a number of years with minimal symptoms. The synovia was completely involved, yet no erosion of bone had taken place.

CASE 3. D. Z., aged 38 years, was admitted to Passavant Memorial Hospital on May 6, 1947, with a history of excision of a xanthoma of the right knee 7 years ago at another clinic. Motion in the knee was never completely regained following the opera-

Fig. 5. Photomicrograph showing fibrosis with the cellular elements in lesser abundance. A well defined area of fibrosis can be seen undergoing hyalinization. The cellular elements are apparently being crowded out and cleft-like areas remain. × 510.

tion, being limited to 170 degrees' extension and 145 degrees' flexion. During the past year pain and swelling in the knee had increased moderately.

Examination of the right knee revealed a well healed median parapatellar incision. There was moderate thickening of the synovia throughout the knee anteriorly, and moderate increase in fluid. No masses were palpable posteriorly. Moderate tenderness was present throughout. No definite nodules were palpable. X-ray examination showed normal bone structures. Routine laboratory tests were within normal limits.

At operation, on May 7, 1947, the entire synovial membrane appeared to be replaced by pigmented, nodular masses of varying size. The entire infrapatellar fat pad had been invaded by yellow and brown pigmented nodular tissue. A small portion of the articular surface of the patella had been eroded by this tissue, as well as a small area of the lateral femoral condyle. Microscopic findings were typical of pigmented villonodular synovitis.

Following surgery there was no increase in motion, and the patient continued to complain of pain of moderate degree in the knee joint. There has been no clinical recurrence of the lesion after 3 years.

This case illustrates the slow recurrence of the lesion after incomplete synovectomy. It is interesting to note that erosion of the bone and cartilage can occur in these lesions, as demonstrated by this case.

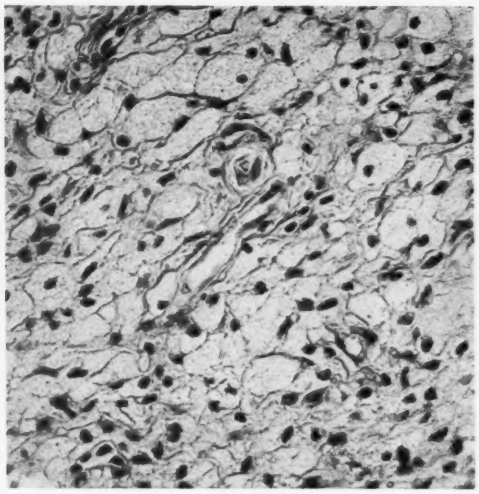


Fig. 6. Photomicrograph showing in detail the characteristic appearance of the lipoid (foam) cells.

CASE 4. P. J., aged 25 years, entered Wesley Memorial Hospital on July 14, 1947, with a history of swelling over the dorsum of the right ring finger of 3 years' duration. The mass had gradually increased in size to extend around the volar aspect of the finger. About 1 year after the first mass was noted, a second mass appeared over the dorsum of the middle phalanx of the left ring finger. There had been no pain or limitation of motion. One year before admission to this hospital the mass was

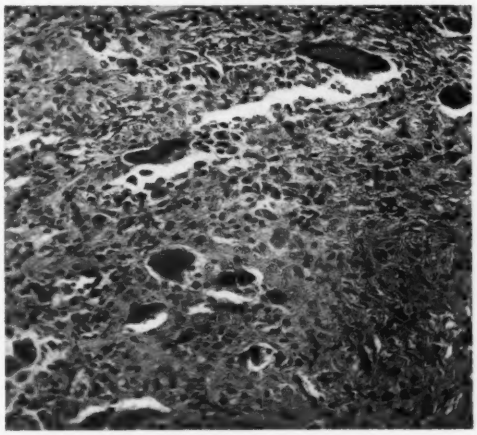


Fig. 7. Photomicrograph showing details of closely compact polyhedral cells with scattered areas of giant cells interspersed. × 455.

a b

Fig. 8. a, Case 4. Soft tissue lesion surrounding the flexor tendon over the volar surface of the proximal phalanx of the ring finger of the right hand. Erosion of the adjacent cortex of the proximal phalanx is well visualized. b, Case 8. Soft tissue lesion causing erosion of the middle phalanx of the index finger over its volar surface.

removed from the right ring finger, but the patient noted recurrence within 6 weeks.

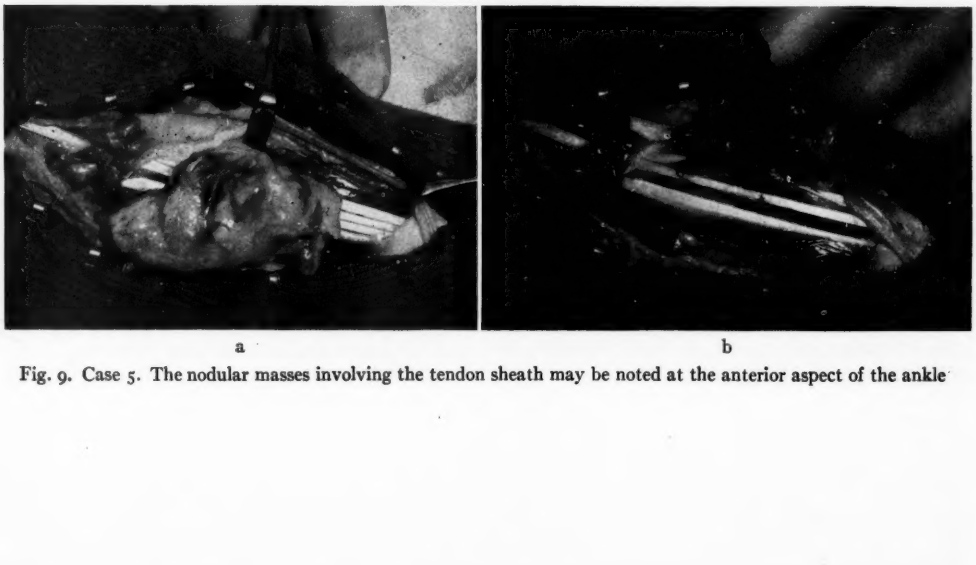
Examination revealed a firm mass attached to the dorsum of the right ring finger in the region of the proximal phalanx. This mass extended around to the volar side of the finger and appeared to be attached to the underlying flexor tendons. A similar mass was present over the dorsum of the middle phalanx of the left ring finger. Neither mass was tender or fluctuant. Laboratory studies, including blood cholesterol, were entirely negative. X-ray examination showed erosion of the proximal phalanx on the flexor surface adjacent to the soft tissue mass. A large soft tissue, brownish red, firm, encapsulated mass was removed from the right ring finger. The lesion surrounded the flexor tendons and appeared to have its origin from the flexor tendon sheath. Histologic examination revealed findings typical of villonodular synovitis.

The postoperative course was not remarkable and there was no evidence of recurrence 3 years later. A normal range of motion was present.

Case 5. M. S., aged 27 years, was admitted to Hines Veterans Administration Hospital on March 24, 1948, complaining of intermittent pain in the left foot. The onset of pain was in 1941, at which time he was struck by a heavy weight on the dorsum of the foot. Later two masses were noted, one on the anterior ankle region and one over the arch. In 1943 the distal mass was excised. The mass in the ankle region gradually increased in size.

On admission, examination showed a cystic mass 2 inches in diameter by 1 inch in thickness immediately above the anterior portion of the ankle joint. Several firm masses could be palpated within the large swelling. There was a healed scar in the region of the distal part of the astragalus. The mass appeared to involve the extensor tendons of the toes. X-ray examination revealed a soft tissue mass over the dorsum of the left foot and ankle. Routine laboratory tests including sedimentation rate were normal.

On April 1, 1948, a brown and tan spongy tumor mass was excised from the region around the extensor tendons of the small toes, where this mass replaced the extensor tendon sheaths. Similar smaller masses were excised from the region beneath the old scar. Postoperative recovery was without complications. Microscopic examination showed



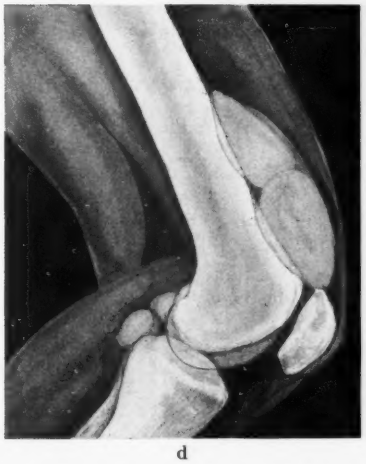
a b

Fig. 9. Case 5. The nodular masses involving the tendon sheath may be noted at the anterior aspect of the ankle

a

c

b



d

Fig. 10. Case 2. a, b, c, and d. Pigmented villonodular synovitis of the knee joint with characteristic appearance. The nodular pattern and synovitis is well visualized. The joint space is normal and there is no evidence of bone erosion. The soft tissue masses are completely intracapsular.

typical cellular structure of pigmented villonodular synovitis. Two years following surgery there has been no recurrence.

This case illustrates the fact that incomplete excision of these tumors results in invariable recurrence. In those involving tendon sheaths and bursae complete excision is usually possible and it should not be necessary to use postoperative x-ray therapy.

CASE 6. V. D., aged 27 years, was admitted to Hines Veterans Administration Hospital on September 13, 1948, complaining of swelling of left knee for 1 year. The onset was gradual and persistent. He was able to walk without pain, although excessive activity brought on aching associated with increase in the swelling. He had noted jaundice for 1 week prior to the onset of knee swelling. Five weeks before admission chills and fever developed and the knee became red and noticeably warmer. After 3 days this subsided. He stated that these symptoms recur with each episode of pain and swelling.

Examination of the left knee showed thickening and tenseness with obliteration of the normal landmarks. Extension was limited to 165 degrees and flexion to 50 degrees. Tenderness was elicited over the collateral ligaments and over the anterior tibial joint margin. The circumference of the left thigh measured 1 inch less than the right. Aspiration of the knee on September 14, 1948, revealed 100 cubic centimeters of bloody fluid. X-ray examination showed only moderate diffuse osteoporosis. Routine laboratory tests including the sedimentation rate were within normal limits. Fluid from the knee joint revealed normal cholesterol and esters, and was sterile.

On October 2, 1948, exploration of the left knee revealed greatly thickened synovial membrane, deep brown in color, villous and friable. The joint surfaces were normal. A synovectomy was carried out, leaving only the inexcessible posterior synovial tissue. The postoperative course was uneventful. On October 16, a course of x-ray therapy was started, 1810 roentgens at 2 centimeter depth being given to the popliteal space in divided doses over 10 days. Microscopic studies showed the characteristic findings of villonodular synovitis. There has been no recurrence clinically in 1½ years.

Following aspiration of bloody fluid from a knee which has been distended for a long

period, without trauma, a diagnosis of pigmented villonodular synovitis should always be considered. A course of x-ray therapy is recommended following synovectomy in these lesions where pathologic synovial tissue remains.

CASE 7. P. R., aged 28 years, was hospitalized on February 6, 1950, complaining of a swelling about the volar aspect of the middle phalanx of the ring finger of the left hand. The mass had gradually increased in size over a 5 year period. There was no history of trauma or pain. There was limitation of flexion of the finger because of the size of the mass.

At operation on February 7, 1950, a firm, yellowish-brown encapsulated mass was removed from the volar aspect of the middle phalanx. This mass occupied the area between the bone and the flexor tendon and had displaced the tendon anteriorly. The mass arose from the tendon sheath. The microscopic findings were compatible with a diagnosis of villonodular synovitis.

At the present time the patient has regained normal, painless, finger motion.

SUMMARY

1. Seven cases of pigmented villonodular synovitis are presented occurring in various sites such as the knee, fingers, and ankle.

2. The lesion appears to be inflammatory in type although a specific causative factor could not be determined.

3. There is a tendency for recurrence of the lesion as shown in 3 of these cases where excision was not complete.

4. The lesion is radiosensitive and x-ray therapy is advisable when the lesion cannot be completely excised.

5. Erosion of the adjacent bone and articular structure may occur so that early excision is advisable.

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THE FATE OF ARTERIAL GRAFTS IN SMALL ARTERIES

An Experimental Study

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THE need for a satisfactory method of bridging defects created by injuries of major arteries has long been recognized. The collateral circulation of a number of regions of the body is inadequate to maintain viability when the principal artery of supply to the region has been destroyed or blocked. This is particularly true in cases in which the main artery to the leg is acutely interrupted. Experience with arterial injuries of the lower extremities among battle casualties in World War II has amply demonstrated that collateral circulation alone cannot be expected to sustain viability of tissue in a sufficient number of instances to justify only the procedure of ligation in conjunction with supportive therapy. Loss of some part of the leg, for example, followed ligation of the femoral and popliteal arteries in 70 to 80 per cent of cases in a series of arterial injuries from World War II reported by Rose, Hess, and Welch. Impaired function also resulted in the legs of a large number of casualties whose extremities survived ligation of the major vessel (22). These findings have been substantiated in the analysis made by DeBakey and Simeone of the collected experience with arterial injuries in World War II. End-to-end anastomosis of severed arteries is the ideal method of repair but in most cases of arterial injury severe enough to jeopardize survival of the extremity, the associated loss of arterial substance is so great that it is not possible to use this method.

Prostheses of metal, glass, and plastics have been given both experimental and clinical trial by a number of investigators with varied results. The shortcomings of rigid prostheses when employed in small arteries where their use is prone to failure from thrombosis or erosion have been sufficiently demonstrated. Initial experiments in this laboratory on femoral artery injury showed that the most satisfactory of the several available techniques for restoring arterial continuity was one in which arterial grafts were used for bridging defects. Fresh and preserved homografts were found to be suitable for the salvage of the extremities of the dog that had received severe arterial injuries (2, 15).

The idea of using transplanted vessel segments for the purpose of uniting divided arteries is an old one, though its successful application has followed the more recent development of satisfactory techniques. Varying degrees of success with arterial grafts in experimental animals were reported by Hoepfner, Carrel, Stich (24), and others, and histologic changes in animal arterial transplants were described by a number of investigators from 1908 to 1911. Stich and Zoeppritz (25) in 1909 reporting the changes in implanted arterial carotid autografts which had remained patent for as long as 14 days observed proliferation of the intimal layer. Necrosis was not seen but rather an active regenerative process was noted. A year later Borst and Enderlen described the alterations occurring in the homografted arterial segments at 18 to 26 days after implantation. These arterial segments appeared completely healed and well preserved. In the microscopic sections wound healing was seen to proceed from the recipient or host tissue which grew out into the transplanted segment of artery. The graft underwent necrosis which was followed by a slow resorption and substitution. They believed that the proliferating endothelium from the recipient vessel grew out over the inner surface of the grafted arterial segment and thus effec-

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tively cut off the blood stream from contact with the donor artery. A comparative study of fresh arterial autografts and homografts was made by Yamanouchi in 1911. He found no alterations in implanted autografts. The homografts in his experiments were observed for as long as 74 days. At 10 days they showed a periadventitial fibroplastic proliferation still possessing a well defined media while at 4 weeks the media was half necrotic and the elastic fibers showed slight changes. These processes steadily progressed and by the seventy-fourth day the media was completely necrotic and moderately thinned, and the elastic fibers were fragmented. The intima had proliferated and covered the entire inner surface except for areas of thrombus. A contradictory opinion on the fate of arterial autografts was expressed by Neuhof in 1923 who believed that the autografts underwent a gradual fibrous replacement so that after many months the differences between autografts and homografts were not appreciable. About the same time, Lexer stated that necrosis was almost never found in the autograft and that after lapses of several months to a year the normal histology persisted. He did not believe that the transformation previously described in the homograft and recognized by him jeopardized the success of these grafts, since their replacement was gradual. Following these accounts no further reported work on arterial grafts during the next 25 years has come to our attention. Despite this encouraging background of experience with arterial grafts no reports have been found of their use in any of the large number of vessel injuries encountered in World War II.

Williamson and Mann in 1947 reported a series of 6 carotid artery homografts in the dog with discouraging results. On inspection at 56 to 62 days only 1 graft in their series showed good function while another had limited function. In larger vessels, the aorta of the dog, outstanding success was obtained by both Hufnagel and by Gross and his associates (8) in the transplantation of arterial homografts. This experimental work and the clinical application of arterial grafts to the repair of congenital defects by Gross and associates (7) served as a stimulus to the present experiments on small artery grafts. Their work was primarily concerned with grafts of the aorta, and it was a matter of some conjecture whether the smaller muscular type of artery such as the femoral would lend itself to transplantation as well as this larger type vessel, for the discrepancies between aorta and femoral artery in size and structure are significant. Outside diameters of about 8 to 12 millimeters are to be expected for the aorta of the dog while the largest size of femoral artery encountered in the present experiments was 4.5 millimeters and in dogs weighing 30 to 50 pounds it was more likely to be 3.5 or 4.0 millimeters in diameter.

It is our purpose to report the late results with arterial grafts of small arteries in experiments designed to simulate acute femoral arterial injury so as to test their value under conditions as near like clinical reality as we could devise. Both fresh and preserved homografts as well as fresh autografts were implanted in the femoral arteries of dogs after the method described in the following, and observations were then made of these grafts at various intervals for as long as 1 year

EXPERIMENTAL METHOD

Arterial grafts were used in the present experiments to restore the circulation in the hind legs of dogs that had undergone an experimental acute femoral arterial injury performed by transecting the hind limb and reimplanting it after the technique described by Halsted and Reichert (2). A surgical division of the soft tissues of the leg was performed just proximal to the mid-thigh level. The femoral artery was ligated and a small segment of it was resected. This procedure effectively eliminated both the main channel of arterial supply and all the collateral vessels which rendered the distal leg severely ischemic. The femur, the sciatic and femoral nerves, and femoral vein were preserved. Leaving these structures intact avoided complications and their severance would not render the leg more ischemic. After the completion of the transection procedure the musculofascial structures and the skin were immediately resutured so that when ischemia was relieved the structures were in place. The femoral artery was later

restored to function by the implantation of several types of arterial grafts in various experiments. In previous experiments (2) it was established that the distal part of the extremity in this preparation remains entirely dependent upon a patent and functioning femoral arterial anastomosis for at least 12 to 14 days. Failure of a graft used to reconstruct the femoral artery during this period is followed in all cases by gangrene of the leg. Fresh arterial autografts, fresh homografts, and preserved homografts were used in the repair of the femoral artery. The autografts were taken from and immediately implanted into the opposite leg of the same dog; homografts were taken 1 to 22 days prior to use and during this interval were stored in a fluid media within tightly sealed rubber-stoppered bottles, and kept at refrigeration temperatures between 1 and 5 degrees centigrade. The storage media consisted of Tyrode's solution to which had been added glucose, homologous serum, penicillin, and streptomycin according to a formula patterned after the storage media originally used by Gross and associates (8). The segments of artery used as grafts measured from 1.8 centimeters to 3.5 centimeters in length and had outside diameters of 3 to 4.5 millimeters. Anastomosis was carried out by a suture technique which utilized a continuous lock suture with No. 000000 silk swedged on atraumatic needles. Throughout the operative procedures a strict aseptic technique was practiced and all wounds were closed without drainage. Penicillin was given to minimize the complicating factor of infection. Anticoagulants were not used in any of the experiments.

EXPERIMENTAL RESULTS

The present report is based on results found in a series of 39 experiments in which the animal survived with a viable extremity and no evidence of gangrene for the critical initial 2 week period following the transection-reimplantation injury. Major wound complications were uncommon and per primam healing was the rule. In this group of 39 experiments the grafts were examined upon sacrificing the animals after periods ranging from 16 days to 12½ months. Data on types of grafts used and results obtained are summarized in Table I.

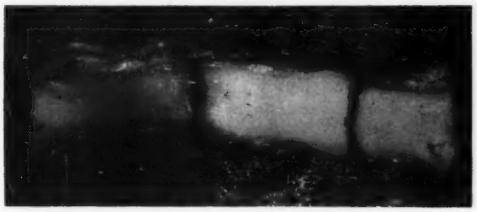

Fig. 1. Preserved arterial homograft. Period of storage, 24 hours. Animal sacrificed and graft inspected at 22 weeks. Graft is patent and intima intact.

Gross description of implanted grafts. Thirty-four, or 87 per cent of the 39 grafts continued good function as demonstrated by dissection and arteriogram. Five of the grafts were found to be completely occluded. Abnormalities ranging from simple discoloration of the intima to a moderate degree of constriction of their lumina were apparent on gross inspection of 18 of the 34 functioning grafts. Sixteen grafts appeared essentially normal. Upon gross inspection all of the autografts were found to be entirely similar both in regard to appearance and texture to the adjoining artery into which they had been implanted. Their intimal surfaces were of normal color and were smooth and glistening. On the other hand, differences in the homografts were just discernible. They were slightly stiffer, less elastic, and paler (Fig. 1).

A variety of small defects and abnormalities that were not evident in the autograft were observed in a number of the homografts although none of these minor defects detracted from the function of the grafts. The most common abnormality was an area of red or yellow discoloration of a few millimeters' diameter involving the intimal surface of the graft. Several of the grafts with discolorations and some without color changes had areas of roughening of the normally smooth intimal

TABLE I.—LATE FUNCTION OF GRAFTS

Type of graft	Total No.	Functioning grafts	
		Number	Per cent
Autograft	5	5	100
Homograft, fresh	10	9	90
Homograft, preserved	24	20	83
Total	39	34	87

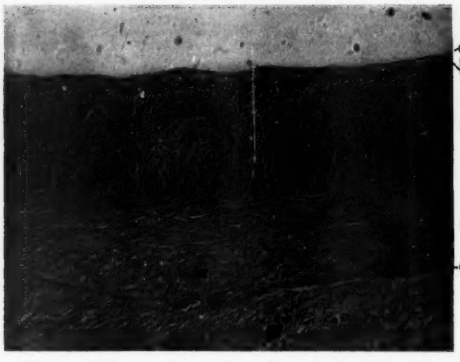

Fig. 2. Microscopic section of fresh arterial autograft. Graft examined at 37 weeks; the over-all appearance is essentially that of a normal artery. *a*, Intima; *b*, inner elastic lamina; *c*, media; *d*, outer elastic lamina; *e*, outer limit of graft. Hematoxylin and eosin stain, ×35.

Fig. 3. Microscopic section of preserved arterial homograft. Examined at 8 months. Thickening of the intimal layer to almost the width of the media can be seen. The paucity of nuclei in the media is evident. *a*, Intima; *b*, inner elastic lamina; *c*, media; *d*, outer elastic lamina; *e*, limits of graft. Hematoxylin and eosin stain, ×35.

surface. A few grafts had smaller nodular projections into the lumen. Two grafts had more serious defects consisting of a central constriction of the lumen which reduced the lumina from a third to a quarter of their normal diameter. One graft had an extensive subintimal hematoma which involved three-quarters of the inner surface without encroachment on the vessel's lumen. These various defects tended to be situated near the mid-portion of the graft instead of having random distribution throughout their lengths. None of the grafts showed an appreciable degree of dilatation nor aneurysm. In Table II it can be seen that the defects occurred most frequently in those grafts that were stored for longer than a week prior to implantation; 75 per cent of these showed such defects. Both fresh homografts and the homografts stored for a week or less showed comparable incidences of defects which were present in about 50 per cent of each of these types. For the most part the inner surface of the homograft was smooth and glistening and except for minor abnormalities they closely resembled normal arterial segments.

TABLE II.—OCCURRENCE OF DEFECTS IN THE ARTERIAL GRAFT

Type of graft	Total No. of grafts	No. of defects	Percentage of defects
Autograft	5	0	0
Homograft, fresh	9	4	44
Homograft, preserved (1-7 days)	12	6	50
Homograft, preserved (8-22 days)	8	6	75

Microscopic description of implanted grafts. Autografts.—On microscopic examination the autografts were found to be quite similar to the adjoining normal recipient artery (Fig. 2). The architecture of each layer was well preserved and their cellular elements had the appearance of viability. In occasional grafts there occurred a low patchy proliferation of intimal tissue but aside from this change there were no features to distinguish these sections from those of the adjacent recipient normal vessel.

Homografts.—Although the autografts and homografts grossly did not show outstanding differences, the differentiation of the two was readily made by microscopic examination. Alterations in the fresh and preserved homografts were identical although the rate of development of characteristic changes was somewhat more rapid in the preserved graft.

Each of the homografts examined late had a thickened intimal layer, the result of the cellular proliferation forming a fibrous lining layer that varied in thickness in different grafts and within the same graft. The beginning of this proliferation was observed as early as 9 days and the process was well advanced by 1 month. In some cases the increase amounted to only a few cells while in others it comprised

a layer equal in thickness to three times that of the normal media. These proliferated intimal cells were embedded in a collagenous matrix and appeared to be active living cells. It is presumed that they grew in from the cut ends of the recipient vessels. Figure 3 is a photomicrograph of a preserved arterial homograft which was removed for examination 8 months after its placement.

The most obvious change observed in the homograft was in the media and consisted of cellular necrosis initially involving the smooth muscle cells themselves. This was followed by the eventual disappearance of almost all cellular elements and was accompanied by a progressive hyalinization of the entire layer. By the second to the fourth week this process was well established. A small number of scattered normal appearing nuclei persisted in the hyalinized substance of the media. They gradually diminished with the passage of time so that only a few remained after a year. The hyalinized media progressively assumed a homogeneous aspect throughout as the reticular pattern imparted by the muscle cells and elastic fiber network disappeared. The hyalinized material itself was not specifically identified, though it was presumed from its staining reaction with the van Giesen connective tissue stain that it was a collagenous ground substance. The thickness of the lamina media was not significantly diminished being less than 25 per cent in each instance. The process in the media might be thought of then, as one of necrosis upon which there is superimposed a fibrous or collagenous replacement of the layer. It is probable that the media thus altered continues to act as an important functional structure of the graft wall.

The elastic tissue throughout the entire homograft eventually became fragmented with separation occurring transverse to elastic elements although there was some longitudinal splitting as well. This fragmentation is most evident in the external elastic lamina and was observed as early as the sixteenth day in the preserved homograft. Only after implantation for 6 months was it a consistent finding in all the homografts. The inner elastic lamina remained well preserved up to about 4 months and then showed only moderate fragmentation.

Immediately surrounding the graft a thin layer of dense fibrous connective tissue was formed by the host tissues which partially replaced the loose outer portion of the adventitia that was removed at graft implantation in these experiments. Penetration of the graft beyond this layer by newly formed blood vessels was not seen except where hemorrhage had occurred.

In the absence of known infection about the graft, a cellular reaction of the host tissues to the graft was not evident. Eosinophiles were conspicuously absent. Foreign body reactions with accumulation of multinucleated giant cells occurred only about the silk sutures of anastomosis but not within the graft itself. Healing at the anastomosis took place by a filling in of the space between the intimal edges of the graft and recipient vessel with a fibrocellular tissue that resembled and blended with the proliferated intimal layers of the adjacent artery and graft. Elastic fibers were not demonstrated at the site of healing. The part of suture material that penetrated the lumen rapidly became covered with intimal tissue.

Other microscopic alterations in the grafts were encountered which served to explain the nature of the processes underlying the abnormalities or defects, and helped to explain the pathogenesis of late graft failures. The red and yellow discolorations visible in the intimal surfaces corresponded microscopically to areas of recent and old interstitial hemorrhage that had taken place into the intima and media. Nearly all hemorrhages were small and of limited extent and presumably arose from small rents in the intimal lining. These areas were abundant with pigment-laden macrophages. Blood vessels frequently had penetrated from the surrounding host tissue to these areas of old hemorrhage, and these were the only instances in which there was any recognizable vascular proliferation from the host into the implanted vessel wall beyond its outer elastic lamina. Small thrombi occasionally were adherent to the vessel wall and were generally associated with the areas of hemorrhage. These superficial areas of thrombosis produced the roughened areas of the intima that were observed grossly. In

the few grafts with noticeably constricted lumina, the bulk of the narrowing was due to similar though larger thrombi that had become organized. The two grafts that were completely occluded were filled with recanalized and organized thrombi. The association of these changes with old intimal hemorrhages suggest that these hemorrhages are precursors of more serious graft occlusion by thrombus.

DISCUSSION

The grafted arterial segment is unique among tissue transplants because of the intimate association of the transplant with the arterial stream. Oxygen and essential metabolic substances are, therefore, immediately available to at least the innermost layers of the cells. There has been some doubt about the normal mechanism of nutrition for the whole blood vessel wall, and the role of the vasa vasorum in supplying the media has not been clear. O'Neil has shown that necrosis of the intimal layer of veins follows the destruction of their vasa vasorum. Arteries have been found to be more plentifully supplied with vasa than veins (14). In the present experiments the arterial autografts persisted as normal, viable segments of artery according to histological criteria and, therefore, it may well be supposed that oxygenation and nourishment of these grafts must have been adequate and remained so, in spite of the lack of perceptible revascularization. It may be assumed that this holds true for the arterial homografts of comparable size and origin, and that the alterations seen in the structure of the homografts was the consequence of other causes. The pronounced histologic alterations in the homografts with necrosis of the smooth muscle cells, hyalinization of the media, and fragmentation of the elastic fibers must be attributed to some specific reaction between the donor tissues and the host. The important role of the immunologic reaction between the recipient organism and the implanted tissue has been stressed by Gross (7) as one of the important factors influencing the success of arterial grafts. In the present experiments and in those of others dealing with arterial transplants an eventual sloughing away or dissolution of the arterial graft such as always occurs with skin homografts was not encountered. It was not possible to ascertain in the present experiment whether the viable appearing nuclei that persisted in the media of homografts after the muscle cells had disappeared were of donor or recipient tissue origin. The nuclei gradually disappeared and only a few remained at the end of a year suggesting that they stemmed from the grafted tissue. The nature of the hyaline alteration of the media was not fully established. The staining reaction indicated it was of a collagenous substance and it may be supposed that it was formed by the persisting cells as a substitution product for the muscle cells that had become necrosed. It gave all indications of surviving as a functional structure of good strength in the graft wall. Although the intimal lining of the vessels was observed to die early, late studies of the graft specimens revealed them to be lined with a thickened layer of intima. Pierce (18) found by special stain techniques that endothelium of homografts disappears after 7 to 10 days of implantation. It was thought originally by Borst and Enderlin that intima from the recipient artery grew out over the donor segment of the artery to cover its inner surface and thus separate the blood stream from the donor tissue. Such an outgrowth of cells from the recipient vessel has been observed to resurface the inner wall of transplanted devitalized segments of arteries (20) and it is likely that the same occurs in the homograft.

The place of anticoagulants in arterial surgery is not well defined. Their value in preventing thrombosis in arterial repair has been supported in both clinical and experimental studies. Their employment has been advised for at least 5 to 6 days following arterial surgery (11). On the other hand, attention has been directed to the hazards of anticoagulants in the treatment of those injured in battle (4). Shumacker and associates (23) recognize that anticoagulants may jeopardize the patient's life in certain operations such as those within the abdomen, thorax, and cranial cavity but they maintain that surgery limited to the peripheral arteries can be undertaken when there exists a full anticoagulant effect. Although it was not intended

that the present experiments should supply the answer to this problem, it has been demonstrated that successful arterial repair with a graft anastomosis can be performed in small arteries without anticoagulants. It is doubted that any improvement over the degree of success obtained with grafts could be anticipated by using either heparin or dicumarol. In fact, a higher percentage of graft failures might accompany the vicissitudes resulting from heparinization in the presence of extensive wounds. The value of anticoagulants in their application to individualized cases is not to be denied. It is believed, however, that the swiftly moving, smooth flowing blood stream is of the greatest importance in the prevention of thrombosis either within the grafts or at the anastomosis. For this to obtain, it is necessary to avoid any constriction or dilatation within the lumen of the graft or at the line of suture. The maintenance of an adequate volume flow of blood is likewise considered essential. If these conditions are supported, the clotting tendency becomes less important. Thrombosis did not occur in these experiments in the presence of intimal necrosis. Freeman has pointed out that the intima of an artery may be crushed over a distance of 1 centimeter without thrombosis as long as blood flow is not permitted to be deficient. Those working with formalin-fixed grafts have concluded that a graft even though its inner surface is not lined by living cells may continue to conduct blood and remain free of thrombus in the absence of anticoagulants (12, 20).

By tissue culture methods Pierce and associates (19) obtained growth of fibroblasts from stored arterial segments that was comparable to that from fresh arteries. They found that viability persisted in stored arteries for at least 7 weeks of storage. Swan and associates found that storage up to 6 months did not make a significant difference in the functional success of aortic grafts, though degenerative changes were more marked in those stored longer than 40 days. Both of these groups of workers were dealing with aortic grafts rather than the much smaller femoral artery of the dog, in which the effects of even a minute defect are many times greater than would be the case in a larger vessel. The methods for graft storage in the present experiments did not differ significantly from those employed by these other workers. In the present experiments a higher incidence of minor defects in the implanted grafts was observed for those stored for longer periods than 1 week. It would be expected that prolonged storage would not affect the early success of the graft but would exert a late influence as in these experiments.

The superiority of the autografts has been demonstrated both by the absence of defects in these grafts and by their normal histology as seen in these experiments in contrast to the much altered histology of the homografts. The principal obstacle to the use of the autograft is the lack of a readily available source of grafts of suitable size. A few arteries such as the radial or ulnar might be sacrificed but their application would be limited since it is desirable to employ donor vessel segments of a size similar to that of the recipient. These arteries might be useful in the repair of an injured hepatic or superior mesenteric artery but are too small satisfactorily to replace the large main peripheral arteries. The subclavian artery has been suggested for autograft use but it is not easily accessible. Arterial homografts from recent cadavers either freshly obtained or stored until ready for use appear to be the most satisfactory means for bridging an arterial defect. The fact that 90 per cent of fresh femoral homografts and 87 per cent of the preserved type functioned well under experimental conditions of a very critical nature speaks well for their usefulness.

SUMMARY AND CONCLUSIONS

In a study of grafts of small arteries gross and microscopic observations were made in 39 animal experiments with observations extending on some implanted grafts for as long as 1 year. Thirty-four of the 39 grafts that survived the initial critical 2 week period showed persistent good function.

Arterial autografts persist as viable segments of artery which are almost indistinguishable grossly and microscopically from the adjacent normal recipient artery.

Homografts, both fresh and preserved, undergo a necrosis of all layers. This is accompanied by a collagenous replacement of the media. The intimal layer is replaced by a fibrocellular layer of variable thickness which is most likely derived from outgrowing cells from intima of the adjacent recipient artery. The histologically altered homograft provides a functioning vessel segment with a structurally sound wall and lining of living cells.

It is evident that autogenous grafts are highly successful in the femoral artery and may be relied upon to produce permanently satisfactory replacement structures. Homografts, fresh or preserved, survive and remain functioning for long periods of time, certainly much longer than that needed for collateral circulation to develop. Arterial grafts of all three types would be useful for bridging defects in cases of human arterial injury or for replacing segments of small but essential arteries sacrificed in extensive radical surgery.

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STUDIES OF NITROGEN METABOLISM IN SURGICAL PATIENTS WITH THE PARENTERAL ADMINISTRATION OF CONCENTRATED HUMAN ALBUMIN AND RED BLOOD CELLS

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IT is only within recent years that surgeons have learned how important a role good nutrition plays in lowering both morbidity and mortality rates associated with major surgical procedures. When food can be taken orally and the digestive and absorptive processes of the gut are unimpaired, the preoperative preparation of the patient is most easily accomplished. However, in many patients the oral route cannot be used and the nutritional needs of the patient must be given parenterally. It was Wangensteen (5) and associates who first showed that human plasma when given intravenously as the sole source of protein could maintain nitrogen balance in man. The monumental work of Cohn and his associates (2, 9, 10) in fractionating human plasma and serum has made available human serum albumin in concentrated form. It was the purpose of this study to determine the effect of human serum albumin alone and in combination with washed red blood cells on nitrogen metabolism when given intravenously as sole sources of protein to surgical patients.

MATERIALS AND METHOD

The human serum albumin solution was supplied us by the American Red Cross in ampuls containing 25 grams albumin and 1 gram acetyltryptophane, diluted to 100 cubic centimeters with buffered aqueous solution. In this form the solution of human serum albumin is not only isotonic and heat stable (so that sterilization for 10 hours at 60 degrees centigrade could be carried out without need for preservatives) but it also contains all the essential amino acids. Twenty-five grams of albumin exert a colloidal osmotic pressure equal to that of 450 cubic centimeters of plasma and the solution contains only 0.2 gram per cent sodium acetyltryptophane.

In all patients studied except the first, the plan of study was the same; i.e., there was an initial period of 4 to 5 days when no proteins were given and the level of nitrogen excretion in the urine and feces determined. This was followed by a second period of 4 to 5 days' duration when albumin alone or in combination with washed red blood cells were given. A final period of 4 to 5 days followed in which again no protein was given to determine if significant amounts of nitrogen were excreted after cessation of administration of the proteins in the second period. The albumin was given in doses of 1 gram per kilogram of body weight and the red blood cells in amounts ranging from 270 to 300 cubic centimeters, which amount represents the quantity obtained from 500 cubic centimeters of whole blood. The daily caloric intake was supplied by 2 liters of 10 per cent glucose and 2 liters of 5 per cent glucose in distilled water given intravenously and amounted to about 1,200 calories. Water alone was permitted by mouth and adequate vitamin intake was assured by intravenous administration.

The 24 hour urine specimens were collected, and tuolene was used as a preservative. Stools and gastric drainages were also saved and their nitrogen contents were determined by the macro-Kjeldahl method. The urea nitrogen, nonprotein nitrogen, amino acid nitro-

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TABLE I.—NITROGEN BALANCE STUDY IN CASE I

Day of observation	1	2	3	4	5	6
Body weight, kgm.	70.6	69.8	68.7	68.4	67.3	67.6
Maximum temperature	101°	102°	99°	98°	99°	98°
Blood pressure	130/80	130/76	124/68	128/68	114/70	130/78
Fluid intake, c.c.	4435	4515	4515	4930	4780	
Caloric intake	1156	1184	1184	1196	1164	
Blood						
Hemoglobin, gm.	14.9					14.1
Hematocrit, %	49					46
Plasma vol., c.c.						2600
Total protein, gm. %	6.65					7.40
Albumin, gm. %	4.43					5.95
Globulin, gm. %	2.00					1.41
Urea nitrogen, mgm. %	18.3					18.6
Nonprotein N, mgm. %	32					34
Amino acid N, mgm. %	6.5					7.8
Creatinine, mgm. %	1.7					1.4
Chlorides, mgm. %	513					538
Urine						
Volume, c.c.	3521	2766	3474	3159	2901	
Specific gravity	1.005	1.005	1.003	1.002	1.009	
Total nitrogen, gm.	12.82	10.65	9.44	7.30	5.95	
Urea nitrogen, gm.	9.58	7.69	7.19	5.62	4.56	
Ammonia N, gm.	0.63	0.53	0.59	0.70	0.58	
Amino acid N, gm.	0.93	0.64	0.50	0.60	0.39	
Creatinine, gm.	1.23	1.24	1.08	1.04	0.96	
Reducing subs., gm.	10.80	3.73	3.99	1.18	8.90	
Fecal nitrogen, gm.	0.14	0.14	0.14	0.14	0.14	Total
Gastric suct. N., gm.	1.1	1.0				bal.
Total N loss, gm.	14.06	11.79	9.58	7.44	6.09	48.96
Albumin intake, gm.	71	70	69	68	67	
Nitrogen intake, gm.	10.93	10.81	10.64	10.59	10.42	53.39
Nitrogen balance, gm.	−3.13	−.98	+1.06	+3.15	+4.33	+4.43

gen, and creatinine of the blood and urine were determined by standard laboratory procedures. Total blood and plasma volumes of the patient were determined by the Evans blue dye method. Hemoglobin values of the blood were obtained by means of the colorimetric method and use of the Evelyn electrophotocolorimeter. Hematocrit values were obtained on venous blood drawn from the patient in the supine position without the aid of tourniquets. Heparin was used as an anticoagulant. A sample of the blood was transferred to an 8 millimeter hematocrit tube and centrifuged at the rate of 3,000 revolutions per minute for 40 minutes. The plasma was then carefully drawn off after the hematocrit value had been noted, and total proteins were determined by the macro-Kjeldahl method. The albumin and globulin fractions of the blood were determined by a modification of the Howe sodium sulfate method. To obtain a more accurate estimation of the nitrogen given, the nitrogen content in each sample of albumin administered was determined separately.

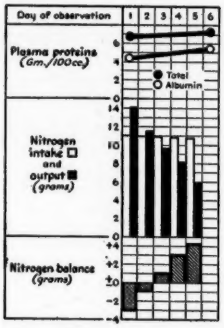

Fig. 1. Nitrogen metabolism study in patient E.S. (Case 1). Administration of concentrated human albumin.

OBSERVATION

Nitrogen balance studies were done on 4 patients.

CASE 1 (Table I, Fig. 1). E.S., University Hospital No. 684321, a 61 year old white male, had a subtotal gastric resection for a carcinoma of the stomach and the study was started on the second day after operation. His nutritional status preoperatively was good and his postoperative course was uncompli-

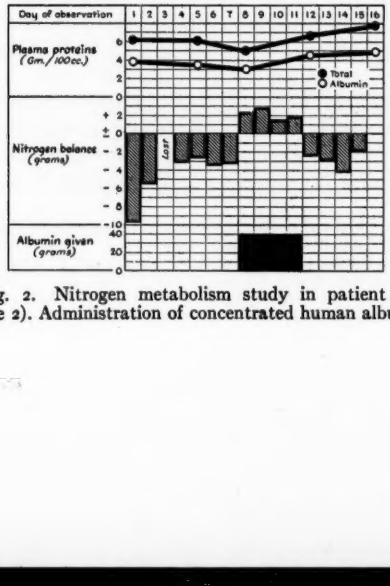

Fig. 2. Nitrogen metabolism study in patient E.F. (Case 2). Administration of concentrated human albumin.

TABLE II.—NITROGEN BALANCE STUDY IN CASE 2

Day of study	1	2	3	4	5	6	7	8	9	10	11	12	13
Body weight, kgm.	40.5	40.2	40.2	40.0	40.2	40.4	40.6	40.7	40.2	40.0	40.1	40.3	40.2
Maximum temperature	98[4]	97[4]	97[4]	98[2]	98[6]	98[6]	98[8]	99[0]	98[0]	98[8]	97[2]	98[4]	98[6]
Blood pressure	110/80							108/76			110/78		114/80
Fluid intake, c.c.	4500	4825	4875	5100	5000	4850	4800	5310	4810	5360	5210	4500	4975
Caloric intake	1188	1148	1200	1192	1144	1172	1199	1132	1116	1140	1116	1120	1134
Blood													
Hemoglobin, gm.	15.6				15.4			13.7				13.3	
Hematocrit, %	49				45			45				43	
Plasma vol., c.c.	2250				2200			2650				2750	
Total protein, gm. %	6.2				6.1			4.9				6.6	
Albumin, gm. %	3.9				3.6			3.0				4.5	
Globulin, gm. %	1.9				2.2			1.7				1.4	
Urea nitrogen, mgm. %	14.2				8.7			6.1				7.1	
Nonprotein N, mgm. %	37.0				30.0			28.3				27.0	
Amino acid N, mgm. %	9.0				6.7			12.0				6.0	
Creatinine, mgm. %	0.5				0.5			0.5				1.0	
Chlorides, mgm. %	576				519			521				550	
Urine													
Volume, c.c.	3832	5170	Lost	3687	3550	3670	3716	4652	3730	3480	4519	3150	3650
Specific gravity	1.001	1.003		1.001	1.002	1.003	1.005	1.005	1.004	1.004	1.003	1.003	1.006
Total nitrogen, gm.	9.84	5.52		3.07	2.87	3.47	3.26	3.41	2.92	2.92	3.87	2.48	2.96
Urea nitrogen, gm.	7.34	3.54		0.79	0.32	0.72	0.34	1.77	0.63	1.54	2.03	0.12	1.42
Ammonia N, gm.	1.35	0.52		1.33	1.42	1.76	1.71	0.98	0.93	0.95	0.81	1.42	0.69
Amino acid N, gm.	0.87	0.65		0.97	0.97	1.06	1.04	1.02	0.86	0.63	0.75	0.91	0.53
Creatinine, gm.	0.81	0.54		0.67	0.48	0.49	0.33	0.53	0.48	0.54	0.63	0.31	0.40
Reducing subs., gm.	2.85	12.67		1.58	13.50	6.97	0.33	16.78	20.9	15.31	21.23	19.53	18.98
Fecal nitrogen, gm.										1.39			
Gastric suct. N., gm.													
Total N loss, gm.	9.84	5.52		3.07	2.87	3.47	3.26	3.41	2.92	4.38	3.87	2.48	2.96
Albumin intake, gm.								40.0	40.0	40.0	40.0		
Nitrogen intake, gm.								5.80	5.80	5.80	5.80		
Nitrogen balance, gm.	−9.84	−5.52		−3.07	−2.87	−3.47	−3.26	+2.39	+2.88	+1.42	+1.93	−2.48	−2.96

cated. For the first 2 days of the study the patient had an elevated body temperature of 102 degrees F. and he was in negative nitrogen balance. For the remaining 4 days, however, during which the study was carried out, when his body temperature was within normal limits he was in positive nitrogen balance. In all, the total nitrogen loss was 48.96 grams and the nitrogen intake was 53.39 grams, a positive balance of 4.43 grams. The body weight dropped from 70.6 kilograms to 67.6 kilograms. Unfortunately, the initial plasma volume determination was not satisfactory, but the hematocrit reading dropped from 49 to 46 and from this we might assume that there had been a small increase in plasma volume. The total protein of the plasma was increased from a preinjection level of 6.65 grams per cent to 7.40 grams per cent on the sixth and last day of the study. Similarly, the serum albumin level rose from 4.43 grams per cent to 5.95 grams per cent. The amount of globulin was, however, decreased from 2.00 grams per cent to 1.4 grams per cent. It may also be noted that the amino acid nitrogen of the plasma increased from 6.5 milligrams per cent to 7.8 milligrams per cent. There were no significant changes in the urea nitrogen, nonprotein nitrogen, creatinine, and chloride contents of the blood during the study. In the urine the amount of nitrogen and urea nitrogen excreted in the urine decreased on successive days as did the amino acid nitrogen and creatinine (Table 1). There was no significant change in the amount of ammonia nitrogen excreted daily. Thus it can be seen that even during a period of increased protein

TABLE III.—NITROGEN BALANCE STUDY IN CASE 3

Day of study	1	2	3	4	5	6	7	8	9	10	11	12	13
Body weight, kgm.	46.8	46.6	46.8	46.9	47.2	47.0	45.2	45.2	44.6	44.3	45.0	45.0	44.8
Maximum temperature	98[1]	98[2]	98[2]	98[9]	98[2]	99[2]	99[8]	99[6]	99[4]	99[4]	100[4]	99[6]	99[4]
Blood pressure	110/70				108/66			100/70					
Fluid intake, c.c.	4000	2000	4600	4000	4180	4180	4275	4205	4060	4000	4000	4010	4000
Caloric intake	1188	420	1380	1200	1200	1156	1188	1192	1160	1196	1160	1116	1176
Blood													
Hemoglobin, gm.	13.6			12.6					11.4				11.5
Hematocrit %	45			42					37				35
Plasma vol., c.c.				2380					2580				2460
Total protein, gm. %	6.3			6.3					6.5				6.8
Albumin, gm. %	3.4			2.8					3.8				3.9
Globulin, gm. %	2.6			2.8					2.4				2.7
Urea N, mgm. %	13.4			7.2					11.5				11.5
NPN, mgm. %	33.0			24.0					31.0				30.4
Amino acid N, mgm. %	7.0			7.8					5.6				6.6
Creatinine, mgm. %	0.5			0.6					0.7				0.9
Urine													
Volume c.c.	2800	3350	3500	3400	2880	5320	3580	3960	2740	3810	3960	4010	4020
Specific gravity	1.009	1.001	1.001	1.000	1.000	1.001	1.000	1.001	1.002	1.006	1.005	1.004	1.005
Total N, gm.	12.96	5.56	3.36	5.88	4.93	5.16	5.36	6.09	5.93	6.23	5.79	6.06	5.96
Urea N, gm.	6.97	3.28	1.52	2.75	2.82	3.03	1.87	3.88	2.55	1.84	2.89	3.81	3.25
Ammonia N, gm.	0.78	0.80	0.74	0.58	0.45	0.33	0.98	0.83	0.77	0.95	0.71	0.36	1.02
Amino acid N, gm.	1.23	0.44	0.58	0.53	0.59	0.65	0.98	1.07	1.04	1.74	1.09	0.92	0.87
Creatinine, gm.	1.34	0.67	0.37	0.68	0.78	0.90	1.10	1.22	0.63	1.54	0.69	0.70	0.76
Reducing subs., gm.	2.94	0.26	0.08	0.08	0.14	11.44	2.97	1.70	9.62	0.65	9.66	21.05	6.43
Fecal N, gm.		0.43			1.29						0.03		
Albumin N, gm.					7.45	7.45	7.13	7.13					
Albumin, gm.					47	47	45	45					
RBC N, gm.													
Total N loss, gm.	12.96	5.99	3.36	5.88	6.22	5.16	5.36	6.09	5.93	6.23	5.82	6.06	5.96
N given, gm.					7.45	7.45	7.13	7.13					
N balance, gm.	—12.96	—5.99	—3.36	—5.88	+1.23	+2.29	+1.77	+1.04	—5.93	—6.23	—5.82	—6.06	—5.96

catabolism which Cuthbertson has shown to follow a surgical procedure, it was possible to maintain a positive nitrogen balance.

CASE 2 (Table II, Fig. 2). E. F., University Hospital No. 701321, a white male, aged 59 years, had a duodenal ulcer with nearly complete pyloric obstruction. The study was carried out preoperatively. During the first 7 days no nitrogen was given to the patient and his caloric intake was supplied by intravenous glucose. A daily nitrogen excretion level in the urine was thus obtained in the control period. He was then given concentrated human albumin solution (1 gram per kilogram body weight) over a period of 4 days, and it will be noted that a positive nitrogen balance ranging from 1.93 grams to 2.88 grams was obtained. During this period of administration of concentrated albumin, there was no increase in the amount of nitrogen excreted in the urine. After the albumin administration was completed, nitrogen loss in the urine during the next 2 days was even less than in the control period and the period of albumin administration. The plasma volume was increased from 2,250 cubic centimeters before the albumin was given to 2,750 cubic centimeters 2 days after cessation of administration of albumin. However, 5 days after the albumin had been given, the plasma volume was back to the pre-administration level of 2,250 cubic centimeters. It is interesting to note that a rather rapid rise of plasma volume from 2,200 to 2,650 cubic centimeters occurred after the giving of the first 40.0 grams of albumin. The total serum proteins on the first day of administration of the albumin solution was 4.9 grams per cent, a drop from 6.1 per cent in the pre-

TABLE III.—NITROGEN BALANCE STUDY IN CASE 3 — (Continued)

Day of study	14	15	16	17	18	19	20	21	22	23
Body weight kgm.	44.4	44.2	45.6	46.0	46.4	45.9	45.4	45.0	45.6	45.2
Maximum temperature	99[6]	98[8]	101[4]	100[0]	100[4]	99[2]	99[0]	98[4]	98[8]	99[8]
Blood pressure		110/80			114/80					100/70
Fluid intake, c.c.	4000	4465	4480	4450	4480	4000	4000	3000	5000	4000
Caloric intake	1200	1196	1200	1200	1200	1200	1192	792	1592	
Blood										
Hemoglobin, gm.						13.3				
Hematocrit %						47.5				
Plasma vol., c.c.						2860				2550
Total protein, gm. %						7.5				6.9
Albumin, gm. %						4.6				3.8
Globulin, gm. %						2.5				2.7
Urea N, mgm. %						10.1				11.5
NPN, mgm. %						28.0				30.0
Amino acid N, mgm. %						7.0				6.9
Creatinine, mgm. %						0.9				0.9
Urine										
Volume, c.c.	Lost	3770	3640	3770	4228	2690	4480	3980	3110	
Specific gravity		1.004	1.004	1.004	1.003	1.005	1.004	1.004	1.002	
Total N, gm.		6.61	5.21	6.16	5.84	6.53	6.89	5.54	9.93	
Urea N, gm.		3.05	2.15	2.02	2.33	2.70	3.13	2.16	3.00	
Ammonia, N, gm.		0.90	0.70	1.77	1.54	1.34	1.29	1.23	2.02	
Amino acid N, gm.		0.99	1.96	1.69	1.29	1.29	1.63	1.59	2.41	
Creatinine, gm.		0.77	0.73	0.68	0.60	0.67	0.89	0.48	0.96	
Reducing subs., gm.		1.09	0.44	0.11	0.09	0.12	2.28	2.27	2.05	
Fecal N, gm.										
Albumin N, gm.		6.97	7.29	7.29	7.29					
Albumin, gm.		44	46	46	46					
RBC N, gm.		9.32	9.04	7.49	9.84					
Total N, loss, gm.		6.61	5.21	6.16	5.84	6.53	6.89	5.54	9.93	
N given, gm.		16.29	16.33	14.78	17.13					
N balance, gm.		+9.68	+11.12	+8.62	+11.29	−6.53	−6.89	−5.54	−9.93	

injection period. However, the plasma volume had risen from 2,200 to 2,650 cubic centimeters and accordingly the total amount of circulating plasma protein dropped only from 1,342 grams to 1,290 grams. After 4 days of albumin administration, the total serum protein was 6.6 per cent and, since the plasma volume was 2,750 cubic centimeters, the total amount of circulating plasma protein was 1,815 grams, a definite increase over the preinjection levels. There were no significant changes in the blood urea nitrogen, nonprotein nitrogen, or creatinine. There was, however, an increase in amino acid nitrogen from 6.7 milligrams per cent in period 1, to 12.0 milligrams per cent in period 2. In this case, too, positive nitrogen balance was obtained with concentrated human albumin solutions. It is important to note that for 5 days after the albumin administration had been completed, there was no increase in nitrogen excretion.

CASE 3 (Table III, Fig. 3). O.K., University Hospital No. 728342, a white male, aged 68 years, with a completely obstructing carcinoma of the esophagus. The plan of study was the same as for Case 2. For the first 4 days no nitrogen was given. During the next 4 days human albumin in amounts of 1 gram per kilogram body weight was given. For the next 6 days no nitrogen was supplied and this period was followed by one of 4 days' duration during which both albumin and washed red blood cells were administered. For the last 4 days of this study, no proteins were given. It will be noted that a positive nitrogen balance was obtained each day that the albumin was given. For the 4 days the average positive nitrogen balance was 1.56 grams. There was no

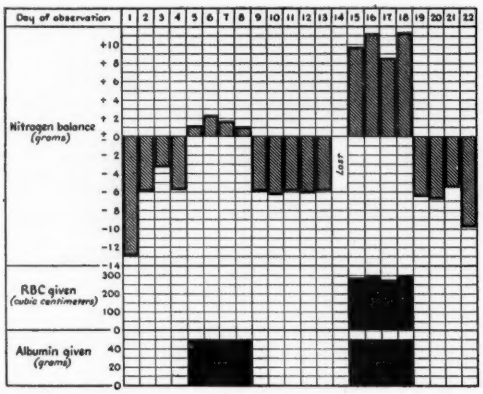
Day of observation
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
Nitrogen balance (grams)
+10 + 8 + 6 + 4 + 2 ± 0 - 2 - 4 - 6 - 8 -10 -12 -14
Last
RBC given (cubic centimeters)
300 200 100 0
Albumin given (grams)
40 20 0

Fig. 3. Nitrogen metabolism study in patient O.K. (Case 3). Administration of concentrated human albumin and red blood cells.

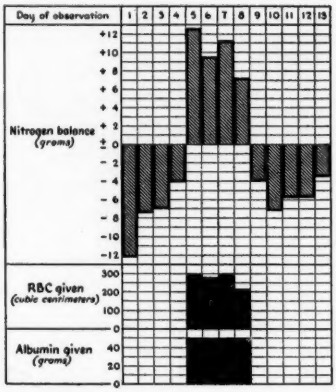
Day of observation
1 2 3 4 5 6 7 8 9 10 11 12 13
Nitrogen balance (grams)
+12 +10 + 8 + 6 + 4 + 2 ± 0 - 2 - 4 - 6 - 8 -10 -12
RBC given (cubic centimeters)
300 200 100 0
Albumin given (grams)
40 20 0

Fig. 4. Nitrogen metabolism study in patient E.G. (Case 4). Administration of concentrated human albumin and red blood cells.

significant increase in urine nitrogen excretion. Although the amounts of serum, protein, and albumin per 100 cubic centimeters of plasma were not significantly altered, because the plasma volume increased from 2,380 to 2,580 cubic centimeters, the total amount of circulating serum proteins was increased from 1,499 grams to 1,677 grams by the injection of the concentrated albumin solution. The total amount of circulating albumin was also increased from 666.4 grams to 980.4 grams.

When both albumin and red blood cells were given, the positive nitrogen balance was much more marked and averaged 10.18 grams for the 4 days of administration. During the last 4 days of this study, although there was a slight increase in the nitrogen excretion in the urine, it was not marked. As noted previously, the plasma volume was increased from 2,380 to 2,580 cubic centimeters by the administration of albumin for 4 successive days, and then dropped to 2,460 cubic centimeters 5 days after the last injection of albumin. Following the administration of both concentrated human albumin and washed red blood cells the total protein and serum albumin fractions of the patients' blood were significantly increased. The day following this third period of study, the proteins were 7.5 grams per cent, the serum albumin 4.6 grams per cent, and the serum globulin 2.5 grams per cent. These are to be compared with the values of the corresponding entities the day prior to administration of both concentrated serum albumin and washed red blood cells; i.e., total serum protein 6.8 grams per cent, serum albumin 3.9 grams per cent, and serum globulin 2.7 grams per cent. Since the plasma volume increased from 2,460 to 2,860 cubic centimeters, the total amount of serum proteins and albumin increased respectively from 1,672.8 grams and 959.4 grams to 2,145.0 grams and 1,315.6 grams. Five days after the period in which concentrated human albumin and washed red blood cells had been given, the plasma volume was 2,500 cubic centimeters and the total serum protein 6.9 grams per cent, serum albumin 3.8 per cent, and serum globulin 2.7 per cent. Throughout the period of study, as well as the periods of control, there were little changes of the blood urea nitrogen, nonprotein nitrogen, amino acid nitrogen, and creatinine. The changes in the urea nitrogen, ammonia nitrogen, amino acid nitrogen, and creatinine in urine throughout the periods of study are given in Table III and Figure 3. It is important to note that throughout the period of administration of serum albumin and the combination of serum albumin and washed red blood cells there were no marked increases in the total nitrogen output in the urine, nor were there any significant increases in the loss of nitrogen in the period following the administration of these substances.

Case 4 (Table IV, Fig. 4). E.G., University Hospital No. 645328, a white 72 year old male, had a duodenal obstruction of undetermined cause. He also had hypertensive and arteriosclerotic heart disease with a blood pressure of 180/100 though he had no evidences of cardiac failure at the time of the study. After a 4 day period when no nitrogen was administered, he was given 50 grams of albumin and washed red blood cells from 500 cubic centimeters of whole blood daily for 4 days. For the succeeding 5 days no nitrogen was given and nitrogen excretion was studied. From Table IV it can be seen that the positive nitrogen balance averaged 9.88 grams. Although no blood volume studies were done on this patient, the fact that the hemoglobin and hematocrit dropped from 14.7 grams per cent and 49 to 12.6 grams per cent and 41 respectively would indicate that an increase in plasma volume had occurred following the administration of the concentrated human albumin and washed red blood cell solutions. The day following cessation of administration of concentrated human albumin and washed red blood cells, the hemoglobin was 15 grams and the hemato-

TABLE IV.—NITROGEN BALANCE STUDY IN CASE 4

Day of study	1	2	3	4	5	6	7	8	9	10	11	12
Body weight, kgm.	63.0	62.2	62.0	62.0	61.6	61.2	62.4	62.2	62.4	62.4	63.0	63.2
Maximum temperature	97.6	98.6	98.2	98.0	98.6	98.6	98.6	97.8	98.0	98.4	98.6	98.0
Venous pressure, H_2O	8.0				7.0		8.0		8.0			
Fluid intake, c.c.	4400	5300	4800	5700	5250	5100	5850	5600	5600	5700	5400	5500
Caloric intake	1200	1200	1200	1200	1700*	1200	1200	1200	1200	1200	1200	1200
Blood												
Hemoglobin, gm.	14.7				12.6				15.1			14.7
Hematocrit, %	49.0				41.0				48.5			48.3
Total protein, gm. %	7.5				6.9				7.4			6.9
Albumin, gm. %	4.8				4.9				5.8			4.9
Globulin, gm. %	2.7				2.0				1.6			2.0
Urea N, mgm. %	19				8							8
Urine												
Volume, c.c.	3910	3530	3540	4150	3670	3500	4150	4200	4450	5030	5160	4900
Specific gravity	1.005	1.005	1.004	1.004	1.003	1.003	1.004	1.004	1.004	1.003	1.004	1.003
Total N, gm.	11.53	7.41	6.97	4.03	4.56	6.92	4.69	6.13	4.90	7.14	5.78	5.88
Fecal N, gm.	0.69						0.67					
Albumin given, gm.					50	50	50	50				
Albumin N given, gm.					7.52	7.52	7.52	7.52				
RBC N given, gm.					9.70	8.79	9.02	5.91				
Total N loss, gm.	12.22	7.41	6.97	4.03	4.56	6.92	5.36	6.13	4.90	7.14	5.78	5.88
Total N given, gm.					17.22	16.31	16.54	13.43				
Balance, gm.	—12.22	— 7.41	— 6.97	— 4.03	+12.66	+ 9.39	+11.18	+ 7.30	— 4.90	— 7.14	— 5.78	— 5.88

*Given about 500 calories and 25 gm. protein by mistake. This N intake omitted from balance (1.6 gm.).

crit 48.5. Despite the fact that the patient had a moderately severe hypertension (180/100) and his fluid intake was over 5,000 cubic centimeters per day, the venous pressure did not vary throughout the periods of study. There was a definite increase in the total amount of albumin produced by the administration of the washed red blood cells and concentrated albumin, for this value of 4.9 grams per cent on the first day of administration of these materials was increased to 5.8 grams per cent on the day following the cessation of injections of concentrated human albumin and washed red cells. As in previous studies, it can be noted that there was no increase in the nitrogen excretion of any significant amount during the period of study in which the substances were administered, as well as for 4 days following the cessation of administration of these materials.

DISCUSSION

Concentrated albumin may apparently be given with relative safety to humans, for (1) reactions following its use are infrequent, (2) it is not antigenic, and (3) serum jaundice is not reported after its administration, probably because sterilization by heat kills the offending virus.

The combination of concentrated serum albumin and washed red blood cells appears to have other advantages, for patients needing parenteral feeding not only have hypoalbuminemia and a contracted blood volume, but they also frequently show varying degrees of anemia.

The low salt content of the albumin solution and the small volume of the combined albumin and washed red blood cells solution permit their utilization in patients whose cardiovascular systems are impaired. If whole blood were to be used in these patients in amounts sufficient to maintain nitrogen balance, cardiac failure might be induced. By elimination of most of the salt and water, much larger quantities of the essential elements can be given in a shorter period of time than would be the case if whole blood were used. In Case 4, for example, a 72 year old male with compensated hypertensive heart disease received amounts of concentrated human albumin equivalent in effective col-

loidal osmotic pressure to 4 liters of plasma, and washed red blood cells from about 2 liters of whole blood in a period of 4 days without producing cardiac decompensation; in fact, his general condition was definitely improved. We have also given concentrated human albumin to dogs in doses of 1 gram per kilogram daily for periods of up to 26 days without producing cardiac decompensation, peripheral edema, or even significant elevations of venous blood pressure.

Our studies with particular reference to positive nitrogen balance must be interpreted with caution. We do not know what the metabolic fate of the injected albumin and red blood cells is. Madden and Whipple believe that homologous plasma given intravenously is utilized by tissue cells as basic building material. Albright suggests that albumin may be used directly in the formation of bone marrow. Riegel and her co-workers believe that approximately 30 per cent of the albumin is retained in the plasma and that most of the remainder passes into the intercellular tissue fluid and hence cannot enter directly into cellular metabolism. They also consider the administered albumin to be gradually broken down rather than used as such by tissue cells.

The large positive nitrogen balance obtained in these studies when concentrated albumin and washed red blood cells were used is based on the fact that we considered the globin fraction of the hemoglobin as protein intake. This in a sense is a "paper" balance and probably does not represent the true state of affairs, for there is considerable controversy concerning the availability of the protein of hemoglobin for cellular metabolism. The work of Sako and his co-workers would lead one to believe that the globin fraction of the hemoglobin may be broken off and partly utilized by the body. The observation on our study that might be of some importance in this matter is that during the period of administration of the washed red blood cells and albumin the increase in total circulating plasma protein and serum albumin is greater than when concentrated serum albumin is used alone. We do not have any direct evidence, however, that the globin fraction of the hemoglobin participated in the fabrication of the plasma proteins.

These studies indicate that concentrated human albumin in doses of 1 gram per kilogram of body weight supplemented with small amounts of tryptophane when given intravenously is capable of maintaining a positive nitrogen balance and producing increases in the blood volume, plasma proteins, and serum albumin fraction of the recipient. When concentrated human albumin and washed red blood cells are given together, the plasma volume, total protein, and albumin fractions of the blood are augmented to a greater extent than when albumin alone is used.

SUMMARY AND CONCLUSIONS

1. Nitrogen balance studies with concentrated human albumin supplied through the American Red Cross have been carried out in 2 patients, and to an additional 2 individuals concentrated human albumin and washed red blood cells were given.

2. Concentrated human albumin in doses of 1 gram per kilogram of body weight appears to be capable of producing and maintaining a positive nitrogen balance in man. Coincidental with the administration of human albumin, there is an increase in the plasma volume, total serum protein, and serum albumin fractions.

3. When concentrated serum albumin and washed red blood cells are given together, the increase in plasma volume, total serum protein, and serum albumin fractions is greater than when the concentrated human albumin is given alone.

4. The low sodium content and low liquid bulk of a concentrated human albumin and red blood solution permit utilization of these materials in patients without any demonstrable increase in the cardiac load.

5. The metabolic fate of the albumin and red blood cells injected is unknown. The theoretical implications have been discussed.

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LIVER FUNCTION STUDIES IN NORMAL AND TOXEMIC PREGNANCY

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THE liver has manifold functions, a tremendous reserve, and an unusual ability to regenerate. Abnormal liver function has been associated with pre-eclampsia-eclampsia for many years because the diagnosis of eclampsia has frequently been based entirely on the periportal hemorrhage which is supposedly pathognomonic of the condition.

There are innumerable tests for various functions of the liver and most of them, at one time or another, have been tried in pregnant and toxemic patients.

The pathology and physiology of the liver are completely reviewed in Lichtman's monograph and in the Macy Foundation transactions of the conferences on liver injury.

Dieckmann, in 1941, stated that there is no "liver of pregnancy." Alterations in many of the functions as determined by various tests occur but the change is usually of little importance. There are disturbances in function which our present histologic methods do not reveal.

Day and Hellestrand used the cephalin cholesterol flocculation, colloidal gold test, the alkaline and acid phosphatase, and the total serum protein determinations in normal and toxemic pregnant patients. They found no correlation between the severity of the toxemia and the degree of liver impairment. They stated that three times as many patients in the normal pregnancy group who had an abnormal cephalin flocculation developed toxemia, as in the normal group with a negative test.

Philpott and coworkers used a number of liver function tests in normal and toxemic patients but stated that the most reliable was probably the cephalin cholesterol flocculation test. They found that abnormal reactions were obtained in 33 per cent of the toxemic patients and in only 6.5 per cent of the normal patients. They administered methionine, plasma, and whole blood to their toxemic patients to treat the hepatorenal syndrome, as they designated it, and stated that their results were promising but not conclusive.

Christhilf and coworkers used the cephalin cholesterol flocculation, thymol turbidity, and bromsulfalein tests in 27 normal, 10 postpartum, and 22 toxemic pregnant patients. They found that bromsulfalein was retained by some eclamptic and pre-eclamptic patients, but reactions to the other tests were normal.

Ingerslev and Teilum first obtained hepatic biopsies from 6 normal nonpregnant women in order to establish a normal pattern as a basis for comparison. They then obtained specimens from normal pregnant women. The histological changes in the liver reported by Hofbauer were not confirmed either by examination of autopsy specimens or by histological study of the biopsies taken from living women. The "pregnancy liver" cannot be maintained as a histologic concept according to their work. In 8 patients with albuminuria and some degree of hypertension near the end of pregnancy and in 6 patients with eclampsia (severe pre-eclampsia in our classification) there were no histologic signs of liver lesions. The biopsy specimens were similar to those obtained from normal nonpregnant and pregnant women. Among 5 cases of eclampsia peripheral precipitation of fibrin with necrosis and hemorrhage in an otherwise perfectly normal liver tissue was demonstrated in only 2 patients. These patients did not die. It appears that the histologic changes make their appearance at the same time as the convulsive attacks since eclampsia could not be predicted in

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advance on the basis of the liver biopsy material examined.

Munnell, in 1948, reported that hepatic blood flow remains unchanged in normal pregnancy. In the severe toxemias of pregnancy there is some suggestion that hepatic blood flow may be increased. The significance of this is not yet established.

A summary of our data is given in Table I and shows that in normal pregnancy, a certain percentage of the patients have an abnormal thymol turbidity, cephalin flocculation, direct serum bilirubin, and urine bilirubin.

Reactions to the liver function tests in the hypertensive patients are not markedly different from those noted in early normal pregnancy, but in the hypertensive patients at term there is an increase in the percentage of abnormal reactions to the thymol turbidity and the cephalin flocculation tests.

In the few pre-eclamptic patients in whom studies were obtained before the clinical syndrome developed a higher percentage of abnormal reactions to the thymol turbidity and cephalin flocculation was noted. Figure 1 shows the results.

We plan to obtain a larger series of these tests begun early in normal pregnancy and repeated at 3 month intervals to determine if it is possible to detect potential pre-eclamptic patients before the usual signs appear.

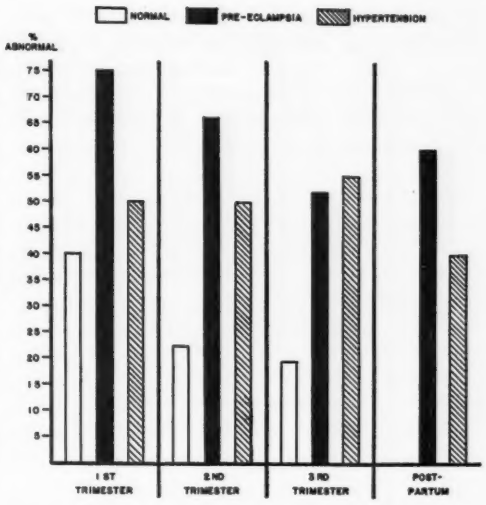

Fig. 1. Mean values for thymol turbidity, cephalin flocculation, serum bilirubin, 1 minute direct and 30 minutes indirect, and urine bilirubin.

SUMMARY

The thymol turbidity, cephalin flocculation, serum bilirubin, and urine bilirubin tests were determined in pregnant patients with pre-eclampsia or hypertensive disease, and in normal pregnant patients. The studies have been of no value in deciding about the

TABLE I.—SUMMARY

	Trimester of pregnancy	Thymol turbidity		Cephalin flocculation	Serum bilirubin, 1 min. direct		Serum bilirubin, 30 min. indirect		Urine bilirubin	
		Mean	Abnormal per cent	Abnormal per cent	Mean	Abnormal per cent	Mean	Abnormal per cent	Mean	Abnormal per cent
Normal pregnancy 85 patients	I	3.1	15	40	0.13	8	0.44	0	0.55	9
	II	2.7	15	22	0.1	15	0.39	0	0.54	12
	III	2.9	16	19	0.1	20	0.36	0	0.53	4.5
Pre-eclampsia 44 patients	I	2.9	25	75	0.1	0	0.7	25	0.62	19
	II	2.6	0	66	0.1	0	0.3	0	0.6	25
	III	3.9	43	51	0.1	31	0.6	17	0.53	16
	Postpartum	3.7	40	60	0.1	20	0.8	24	0.62	14
Hypertensive disease 23 patients	I	2.4	0	50	0.04	0	0.7	17	0.6	13
	II	2.1	0	50	0.1	14	0.5	0	0.55	17
	III	3.8	33	54	0.05	0	0.8	18	0.38	0
	Postpartum	3.4	20	40	0.07	10	0.4	10	0.43	13

diagnosis or prognosis of patients with pre-eclampsia or hypertensive disease in pregnancy. The cephalin flocculation test may possibly indicate in early pregnancy those patients who may develop pre-eclampsia in the last trimester of pregnancy.

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A PSYCHIATRIC EVALUATION OF PSYCHOSURGERY

THE field of psychosurgery has undergone great technical evolution in recent years. At the present time there are at least six different types of operation on the frontal lobe currently being used for the treatment of mental disorders.

The relative merits of these six different operations in the treatment of specific categories of mental disease greatly need clarification.

At the Clinical Congress of the American College of Surgeons in Boston during October, 1950, a special symposium was presented on the "Evaluation of the Results of Surgical Procedures Undertaken for the Relief of Psychoses." Six distinguished psychiatrists, each an authority on some particular aspect of this subject, were invited by the surgeons to be the principal collaborators in that symposium. Each of these psychiatrists presented on that occasion a closely written summary of his own observations and impressions regarding the efficacy of the different surgical techniques employed in the treatment of mental disease. These six reports summarize in an unusually authoritative and concise manner the therapeutic status of psychosurgery at the present time.

JOHN E. SCARFF.

PRINCIPLES GOVERNING THE SELECTION OF CASES FOR PSYCHOSURGERY

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BRAIN surgery in psychiatric disorders is no specific means of treatment of any particular disease. It is applicable in a great variety of conditions because it decreases the emotional impact of many different symptoms. The common feature of all psychosurgical procedures is the interruption of frontal lobe fibers; the reduction in functioning frontal lobe tissue thus produced diminishes primarily the patient's anxiety. Anxiety is a symptom common to many different psychiatric conditions. Therefore, the indications for psychosurgery are manifold.

The more symptomatic value of psychosurgery, on the one hand, and certain unpleasant personality changes associated with frontal lobe surgery, on the other hand, make it necessary to limit the operative procedures to patients who do not respond to any other type of therapy. This limitation makes the selection of cases for surgery an extremely responsible task. Although the selection remains the problem of the psychiatrist, the surgeon working in this field should know which treatments should be applied in a given patient before surgery is considered.

The largest group of patients in any mental hospital consists of those suffering with dementia precox or schizophrenia. These cases constitute also the largest group of patients subjected to lobotomy. Although such patients do not show the most convincing results after psychosurgery, patients so treated will continue to be the most important group because the other methods of treatment available for the relief of schizophrenia are so inadequate.

Before surgery is used in the treatment of schizophrenia, the patient should be subjected to the so called shock, the insulin coma, and the electric convulsive, therapy. I am inclined to start all patients with acute schizophrenia on 20 electroconvulsive treatments giving 3 treatments a week as a routine measure. If the response is striking but the patient relapses after discontinuance of the treatment, another series of 10 treatments is added. If the patient is again symptom free but suffers a relapse, a last attempt with electroconvulsive

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therapy can be made, the so called intense or "confusional" treatment being applied. Application of 2 to 4 convulsions every day brings the patient to a state of utter confusion and temporary "dementia."

When the failure of straight electroconvulsive therapy has become obvious, insulin coma treatment is instituted without further delay. Many workers prefer to start with the insulin or the combined insulin-convulsive therapy. If patients treated with insulin alone fail to improve, electroconvulsive therapy should be added before surgery is considered. In reviewing the history of a case, the reports pertaining to insulin treatment given elsewhere are meaningless unless it is specified that the necessary 50 or 60 comas were deep hypoglycemic comas.

In cases of full remission under any type of shock therapy but with later relapse, another course, preferably combined insulin-convulsive treatment, should be instituted under any circumstances before lobotomy is considered. In view of the undeniable side-effects as well as the immediate operative risks, the psychiatrist should be reluctant to recommend surgery in patients who have relapsed only after a long and satisfactory remission. However, when repeated remissions obtained following shock therapy are not only short but also poor in quality, early psychosurgery is fully justified even before a year of continuous illness has elapsed. No strict rules should be postulated for the waiting period prior to surgery.

There is no evidence that previous shock treatments add to the hazards of surgery. No relation between convulsive therapy and postoperative convulsions can be assumed because convulsive therapy does not predispose to epilepsy; in fact it is even used in its treatment.

Among the various subtypes of schizophrenia, the hebephrenic group shows the largest number of failures after shock therapy. Unfortunately, hebephrenics are also poor risks for psychosurgery because they offer primarily emotional flattening and disorganization of thought. The so called secondary symptoms in schizophrenics such as delusions, hallucinations, aggressive tendencies toward themselves and others can be modified by psychosurgery. These symptoms are most frequent in catatonic and paranoid schizophrenics. Results are best if the patients have not been sick for a very long time and have not become deteriorated. It is often difficult to determine the degree of deterioration in an unco-operative patient. We have found it practical to give such patient 3 or 4 electric shock treatments as a prognostic test; if these treatments elicit a temporary improvement the conclusion is justified that the condition is still reversible and might be affected by surgery.

There are two groups of schizophrenics in which deterioration usually does not occur and therefore, in them, the best results are secured after frontal lobe surgery. The first group is made up of the late paranoids with onset of the disease after the age of 40. These patients are troubled by severe delusions but their total personality, aside from their delusions, remains well preserved. The second group is made up of the so called pseudoneurotic schizophrenics, as described by Hoch. These patients primarily present neurotic symptoms and under the diagnosis of neurosis are often treated as neurotics for many years. Closer diagnostic scrutiny, however, will reveal a rather bizarre train of symptoms, somatic delusions, and other schizophrenic features. This group responds favorably to treatment; also less radical operations are usually sufficient for satisfactory outcomes.

The group of patients suffering from manic depressive psychoses will rarely be subjected to psychosurgery because they respond well to electric shock, even if they have repeated episodes. We are disinclined to try an operation which leaves lasting scars on the personality. Our attitude is the same in regard to involutional melancholia. In such patients electric shock therapy is equally satisfactory in practically all cases. Involutional psychosis with paranoid characteristics responds less well to shock therapy and although such treatment should be applied intensively in all cases of this group, in some patients surgery will be necessary.

This is even more true in a group described as hypochondriacs. These patients complain of characteristic somatic delusions and make life miserable for themselves and for those around them. Although they respond poorly

to electroconvulsive therapy, nevertheless it should at least be tried. Such patients are excellent risks for psychosurgery; the disappearance of their many aches and pains forms an interesting link to operations for intractable pain in nonpsychotics.

Other psychiatric patients such as mental defectives, epileptics and so on, have been operated upon occasionally to correct their aggressive behavior. Surgical attempts in psychopaths, homosexuals, and criminals have been reported but the results are not promising for the reason that frontal lobe surgery does not remove but rather emphasizes bad character traits.

The large group of patients with psychoneurosis presents the most difficult problem to the psychiatrist in making his decision as to the advisability of psychosurgery. Although such patients offer by far the best promise of favorable outcomes, the side-effects of operation count more heavily in psychoneurotics. These patients are often gifted people and potentially able to hold even highly responsible positions. For them psychotherapy is the treatment of choice and should be tried skillfully and consistently. Shock therapy is hardly indicated in these patients. Less radical psychosurgical procedures should be considered and are almost always successful even in those patients with types of psychoneurosis most resistant to treatment. If patients with severe neurosis, such as an obsessive-compulsive neurosis, have been prevented for years from leading normal lives on account of their symptoms, surgery is definitely indicated. One essential to success in psychosurgery is the proper selection of cases. A second essential is the selection of the correct procedure for the individual patient.

LOBOTOMY

A Comparison of Prefrontal Lobotomy with Transorbital Lobotomy

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IN the Spring of 1948 Watts and I terminated our series of prefrontal lobotomy cases, with a total of 624 patients, 702 operations. Since all of the patients have been followed for a minimum of 2 years and up to 14 years or until death, this series is available for comparison with other series as regards the four criteria which are of the greatest concern to the practical surgeon, namely: safety, effectiveness, accuracy, and availability.

Prefrontal lobotomy (Freeman and Watts) is performed through burr holes placed in the coronal suture. The white matter of both frontal lobes is severed usually in the plane of the coronal suture and sphenoidal ridge. Variations are made according to the supposed needs in each case. It has been established by our work (4) that incisions placed too far anteriorly do not relieve the mental disorder, while those placed too far posteriorly are crippling to the personality. Lobotomy fails in most instances because, in deteriorated patients, it is impossible to place the lesions sufficiently far back to relieve the psychosis without at the same time damaging those personality characteristics that are necessary for living in a social environment. A patient with a deteriorated precox, we have said, looks and acts the same with or without his frontal lobes.

Table I gives the status of patients surviving 2 to 14 years after prefrontal lobotomy. Seventy per cent of the patients are able to live outside of institutions, and about half of the 70 per cent are usefully occupied. Subdividing the patients according to diagnostic type, it is found that patients with dementia precox are somewhat less likely to respond to prefrontal lobotomy with effective social capacity than those suffering from affective disorders like involutional depressions or from various types of psychoneuroses. Neverthe-

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TABLE I.—STATUS OF LIVING PATIENTS 2 TO 14 YEARS (1950) AFTER PREFRONTAL LOBOTOMY

Diagnosis	No.	Employed %	Keeping house %	Retired %	Home %	Institution %
Schizophrenias	316	18	8	1	36	37
Affective disorders	119	4	44	12	21	19
Psychoneuroses, etc.	115	34	20	3	23	20
Pain cases	8	12	12	..	50	25
Total	558	18	18	4	30	30

less, more than 1 out of 4 patients with dementia precox is leading a socially useful existence and for a sufficient length of time that stabilization has probably occurred. Relapses after 2 years of effective working capacity are unusual; indeed it often requires 2 years or more for the patient to complete his convalescence after his psychosis has been interrupted by lobotomy.

Table II presents an estimate of the results of prefrontal lobotomy based upon the whole 624 cases. Including the small series of patients that were operated upon for severe and uncontrollable pain, the case fatality has been about 3 per cent, and the operative mortality (including 78 reoperations) has been 2.3 per cent. Thus lobotomy performed by the so called closed or blind method (Watts and I prefer the word "precision") has been within reasonable limits.

We consider that 75 per cent of the patients have benefited from lobotomy. The failures are mostly in those patients in whom deterioration before operation was too great to allow much hope of successful adjustment.

TABLE II.—RESULTS OF PREFRONTAL LOBOTOMY, 1936–1950

Diagnosis	No.	Good %	Fair %	Poor %	Deaths*	
					Operative %	Later*
Schizophrenias	332	33	40	25	2	11
Affective disorders	147	54	26	19	1	26
Psychoneuroses, etc.	127	47	27	21	5	6
Pain cases	18	33	45	..	22	6
Total	624	41	34	22	3	49

*Later deaths are not included in the statistics except as to the result: good, fair, poor.

There have been some patients, particularly with psychoneuroses, in whom the operation of prefrontal lobotomy seems to have been too extensive for satisfactory resolution of their difficulties. These patients have been too completely relieved of their fears and their aches, and have lost something of their consciences as well, so that they have turned out to be extremely aggressive and disagreeable, a burden to their families that is all the more intolerable because the patients are no longer complaining invalids. One can feel sorry for a poor sick suffering patient even if he is known to be a neurotic, but when the neurosis evaporates and reveals a lazy, rude, irresponsible individual, it is difficult to sympathize with the patient who is still as sick as ever, only in a different way.

Some of the failures have also been due to complications, particularly postoperative epilepsy and incontinence. Convulsive seizures occurred in about 10 per cent of the prefrontal lobotomy series, although in most cases they yielded to medication. Permanent incontinence has resulted in about 1 per cent of patients, all of them having had posterior incisions.

During the latter part of our series, Watts and I developed a degree of accuracy in the placement of lesions that was flatteringly designated as "uncanny" by Poppen himself. We estimated that deviation by as much as 5 millimeters in the plane of the incision either anteriorly or posteriorly along the sagittal axis of the brain would result in failure of the operation. Therefore, the tolerance we allowed ourselves was 2 millimeters, and this was achieved in a high proportion of the cases. It was a serious effort, since we realized that an anterior operation was useless and a posterior operation was ruinous. Most of the patients coming to secondary operations were those in whom we had underestimated the severity of the psychosis and therefore had to go back and revise the incisions posteriorly. In about half of the secondary operations the results have been worthwhile.

Prefrontal lobotomy is a major surgical operation, and while it has been carried out by the general surgeon, it is usually left to the neurological surgeon. This fact limits the

value of this type of operation, especially when one considers that there are some 600,000 patients in mental hospitals in this country, and that most of the neurological surgeons are fully occupied with their own problems of tumors and discs, pain syndromes, epilepsy, and head injuries. The same limitations are present in other types of psychosurgical procedures that require opening the skull. Nevertheless, prefrontal lobotomy can confer a great boon on a large number of patients who are hopelessly ill and suffering with severe mental disorders.

The series of prefrontal lobotomy patients for which Watts and I are responsible may be taken as a target for others to shoot at. We know what can be accomplished by this method and what the difficulties and dangers are. We have brought the indications and contraindications (7) into a somewhat more definite state and have recognized our limitations in dealing with certain types of mental disorder.

TRANSORBITAL LOBOTOMY

Soon after the original publications of Egas Moniz, an Italian psychiatrist, A. M. Fiamberti, proposed the approach through the orbit, and claimed that the method was safe, simple, and swift, although he gave no figures on its effectiveness. This method was slow in gaining recognition by other investigators, and it remained latent for nearly 10 years. Then, in 1946, after considerable study of the anatomic relationships, I developed possibilities of the transorbital approach (2).

The technique of transorbital lobotomy is quite simple (3). Recovery from transorbital lobotomy is prompt, many patients being ready for the next meal and sleeping that night without sedation. Hospitalization lasts only a day or two and the swelling and discoloration of the eyelids disappear within a period of 2 weeks. Briefly disabled patients are back at their accustomed tasks by the end of a month.

Operative mortality following transorbital lobotomy is less than 2 per cent. Most of the deaths result from lacerating small arteries at the base of the frontal lobe. In 4 cases of postoperative hemorrhage a cannula was inserted through the operative opening and the clot was aspirated, following which the wound was irrigated with saline until the bleeding stopped. Two of these patients recovered satisfactorily but 2 others died. In 2 other cases of postoperative hemorrhage treated by spinal puncture (since they did not seem too serious), meningitis developed that was quickly brought under control by penicillin. There have been no other infections. One patient lost the sight of an eye when the instrument broke in making the deep frontal cut. Only 2 patients have developed convulsive seizures. One patient suffocated from carcinoma of the throat and 1 died 19 days later of pulmonary embolism, having survived an intracerebral hemorrhage at the time of operation.

On the basis of some 500 cases of transorbital lobotomy, therefore, it may be said that the safety factor is high.

Table III shows the status of 312 patients followed for from 1 to 4 years after transorbital

TABLE III.—STATUS OF LIVING PATIENTS 1 TO 4 YEARS (1950) AFTER TRANSORBITAL LOBOTOMY

Diagnosis	No.	Employed %	Keeping house %	Home %	Institution %
Schizophrenias	181	19	15	21	45
Affective disorders	82	15	36	28	21
Psychoneuroses, etc.	43	23	44	28	5
Pain cases	6	16	17	50	17
Total	312	18	25	25	32

TABLE IV.—RESULTS OF TRANSORBITAL LOBOTOMY 1946–1950

Diagnosis	No.	Good %	Fair %	Poor %	Deaths	
					Operative %	Later*
Schizophrenias	178	37	23	39	1	3
Affective disorders	75	67	17	15	1	5
Psychoneuroses, etc.	47	56	32	10	2	2
Pain cases	16	16	17	50	17	9
Total	316	47	23	28	2	19

*Later deaths are not included in the statistics except as to the results: good, fair, poor.

Note: Nineteen schizophrenics had a subsequent prefrontal lobotomy with good result in 2; fair result in 7; poor result in 10. Thirteen schizophrenics had a subsequent transorbital lobotomy with good result in 2; fair result in 3; poor result in 8. Twenty patients (6%) were followed less than a year and do not appear in the statistics.

lobotomy. The results in terms of social effectiveness are not quite as good in the dementia precox group, since nearly half of them are still hospitalized. On the other hand, the disastrous effects of major lobotomy in cases of psychoneurosis are almost absent. The overall picture is pretty much the same for the 2 types of operations, 68 per cent of patients being able to live outside of institutions after transorbital lobotomy as compared with 70 per cent after prefrontal lobotomy. Thus the factor of effectiveness of transorbital lobotomy seems to have been established.

Comparison of Tables II and IV, concerning results in the 2 types of lobotomy, shows that the minor operation is less successful in dementia precox cases but more successful in the other types of mental disorder. Since half of the patients were operated upon without the deep frontal cut, some improvement in the statistics may be expected in the future. I believe that transorbital lobotomy can replace prefrontal lobotomy in all cases except in those patients showing extreme and prolonged violence, and in psychotic children. In both of these types maximal operation is the only effective procedure and necessarily leads to a rather vegetative condition.

The question of accuracy in the placement of lesions has become somewhat academic as the result of the work of Pool and others who believe that there is a quantitative rather than a topographic relationship between the area of frontal lobe inactivated and the clinical result. Nevertheless, the accuracy of transorbital lobotomy is apparently not inferior to that obtainable by other methods.

There remains the question of availability, and in this respect transorbital lobotomy is the method of choice in institutional practice.

CONCLUSIONS

1. Prefrontal lobotomy (Freeman and Watts) was performed in 624 patients. These are compared with 316 cases of transorbital lobotomy.

2. Transorbital lobotomy is safer, about equally effective, and far more available than prefrontal lobotomy.

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PSYCHIATRIC EVALUATION OF RESULTS FOLLOWING UNILATERAL PREFRONTAL LOBOTOMY UNDER DIRECT VISION

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SEVEN years of experience with the lobotomy operation, with a case load of 550 patients, should offer the basis for drawing some conclusions. In a very general way it is our opinion that the operation has a beneficial result and leads to better social adaptation in a high percentage of patients chronically ill with mental disorders. It is a procedure that carries with it certain hazards and, in some instances at least, is followed by symptoms that are unsatisfactory. It should properly be reserved for patients who appear to have little chance of recovery or of marked improvement by any

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TABLE I.—MENTAL STATUS AND WORK ADJUSTMENT 1 TO 4 YEARS AFTER LOBOTOMY

Mental status	Total No. patients	Work adjustment		
		Good	Fair	Poor
Good	48	23	19	6
Fair	50	12	12	26
Poor	83	13	18	52
Total	181	48	49	84

TABLE II.—RESIDENCE AND MENTAL STATUS OF PATIENTS AT TIME OF FOLLOW-UP

Residence at follow-up	Total	Mental status		
		Good	Fair	Poor
Community	77	45	23	9
Private hospital	7	1	2	4
State hospital	97	3	25	69
Total	181	49	50	82

other available procedure or by the mere lapse of time alone. The following remarks will attempt to summarize the studies and experience on which these conclusions have been built.

The bilateral frontal lobotomy performed as an open operation according to the method of Poppen has been used in the great majority of the cases, namely in 469 of the 550 cases. In the 81 remaining cases patients have had a modification of the technique in the form of a "partial operation." Of these, 44 were bimedial, 37 were unilateral with 16 on the right side and 21 on the left side.

Follow-up as of January, 1950, of patients who had been operated on before June, 1949—amounting to a total of 454 (434 bilateral, 14 bimedial, 6 unilateral)—showed that 181, or 40 per cent, were living at home, 245, or 54 per cent, were in hospital, 23, or 5 per cent, had expired, and 5, or 1 per cent, were lost from the follow-up. Previous intensive study of the condition of 205 consecutive cases gave essentially the same percentage distribution. These findings concerning the latter group have been reported in detail in the volume entitled *Studies in Lobotomy* published in 1950. Of these 205 cases, 17 patients had died and a few could not be located. There remained 181 patients whose condition could be evaluated 1 to 4 years after the operative procedure.

Table I presents the mental status and the work adjustment of this group. Time does not afford an opportunity to compare the work adjustment following the operation with the adjustment which existed prior to illness. Suffice it to say that prior to the illness only about one-half of the patients had a good work adjustment and about one-third had a fair work adjustment.

The next table (Table II) indicates the residence and mental status of patients at the time of follow-up.

A follow-up study of patients operated upon 5 years or more previously is in process. Forty-one patients have been studied up to this point. Twenty are in hospital, 19 are home, and 2 have died from intercurrent diseases. Of the 39 remaining patients the mental status has been established in 37 (Table III). Of these the mental examination is recorded as good in 12, fair in 14, and poor in 11. Nineteen of the 37 patients are at home and 18 in hospital. The work adjustment is known in 36 of the patients, being good for 12, fair for 6, and poor for 17. Of the 41 cases making up this group, 1 has been returned to hospital from home during the 5 year period and 1 has been discharged from hospital to home. Our

TABLE III.—FIVE YEAR FOLLOW-UP

Residence	No. cases	Mental status				Work adjustment			
		Good	Fair	Poor	Unknown	Good	Fair	Poor	Unknown
Home	19	10	8	1	0	7	4	6	2
Hospital	20	2	6	10	2	5	2	11	2
Total	39*	12	14	11	2	12	6	17	4

* Two patients expired

TABLE IV.—FOUR TO 17 MONTH FOLLOW-UP

Type of operation	No. cases	Markedly improved	Moderately improved	Slightly improved	Unimproved
Bilateral	14	3	2	5	4
Bimedial	17	3	9	2	3
Unilateral	15	3	2	9	1
Totals	46	9	13	16	8
Per cent		20	28	35	17

study indicates that the condition existing at the end of approximately 1 year after operation is very likely to be maintained for at least 5 years.

Of the group of 205 patients convulsive seizures occurred in 12 per cent. More than one-half of those having recorded seizures have had but one or two. In most instances indeed the seizures are readily controlled by anticonvulsives, but there is an occasional case in which seizures become a very distressing complication.

The electroencephalographic and psychological examinations throw a little more light on the defects produced by the operation than does the clinical examination. At any rate, it is more easily demonstrated. Of the 5 year follow-up group, 21 had electroencephalographic examinations at the end of the period of observation. Five showed normal tracings, 5 borderline tracings, and 11 showed distinctly abnormal patterns. Of the definitely abnormal patterns, all had a frontal location of the dysrhythmia. It is of some interest that there appeared to be no relationship, however, between the electroencephalographic findings and the clinical condition of the patient as far as his capacity to adapt to his environment. Thus patients with normal electroencephalograms may have done poorly from an over-all clinical standpoint, whereas patients with abnormal electroencephalograms may have run a good clinical course. And, indeed, patients with epilepsy may get along well in the community.

The most important finding of the psychological laboratory relates to the question of organic defect which is apparently best shown by impairment of abstraction capacity. Twenty-seven of the 5 year follow-up patients were studied in this regard. No impairment of abstraction ability was found in 9, 2 showed a borderline impairment and 16 showed definitely impaired abstraction capacity. The fact that 9 of the patients showed no impairment is evidence that the operation need not in itself cause impaired function as measured by the currently available tests. It is interesting to note that there was no relation between the test evidence of abstraction impairment and the general adaptive capacity of the individuals, some showing considerable impairment in abstraction having done very well from a clinical viewpoint and some who showed no test evidence of impaired abstraction having achieved only a poor clinical status.

The final table, Table IV, presents a preliminary appraisal of what might be considered a pilot study as to the clinical results following 3 types of surgery, namely the standard bilateral, bimedial, and unilateral operations. The bimedial procedure is similar to the standard bilateral with the difference that only the medial portion of the frontal lobes is cut. The unilateral is similar to the standard operation but is done on only one side, either left or right. The number of patients who have been subjected to comparative study is too small to allow any definite conclusions, but it would appear that the results which are obtained through the bimedial method are at least as satisfactory as those obtained when the standard technique is used.

CONCLUSION

The experience of the Boston Psychopathic Hospital with the use of lobotomy operations in long-standing psychotics has produced results which appear to be relatively satisfactory. In most patients real improvement in behavior has resulted, making the life of the patient much more comfortable. In at least 40 per cent of the cases life outside of the institution has been possible; about one-half this number of patients have become relatively self-supporting individuals. An assessment of effect following procedure is hard to make. Psychological tests have not been of great help in this regard. It would seem that in some instances no evidence of any type of loss is demonstrable.

EVALUATIONS OF THE RESULTS OF TOPECTOMY OPERATIONS

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TOPECTOMY is a fractional ablation of the frontal lobe cortex. The resection concerns only the gray matter separating the white matter almost entirely. The amount of tissue removed is usually between 25 and 35 grams on each side. This operation was described in the book, *Selective Partial Ablation of the Frontal Cortex*, which contains the experiences with topectomy gained on the Columbia-Greystone Project.

The State of New York and Columbia University instituted another project to study topectomy in mental patients. These operations were carried out at the Psychiatric Institute by Dr. Pool and his staff, and the psychiatric observations were made by me and my collaborators. We are reporting here on a case material of 105 patients who were operated upon. The patients who were used in the Project were mainly schizophrenics falling into the hebephrenic (21), catatonic (22), paranoid (25), mixed (15), and simple (1) subgroupings as Table I indicates.

Twenty-one patients operated upon are designated in the table as suffering from a pseudopsychoneurotic form of schizophrenia. In this group we had patients who showed obsessive-compulsive and phobic manifestations with the underlying structure of schizophrenia. In these patients, diagnosis would probably have been made of severe obsessive-compulsive neurosis or anxiety hysteria by those who do not consider them as belonging to the schizophrenic reaction group.

No patient was operated upon who was not sick for several years prior to the operation and who did not receive shock treatment, psychotherapy, or both. The patients operated upon showed different degrees of deterioration. Thirty patients showed none or minimal, 15 slight, 43 marked, and 17 very marked deterioration. The level of deterioration was determined on the basis of the intellectual and emotional functioning according to the usual psychiatric criteria.

Table II shows the outcome of the operations. One per cent of the patients recovered; 2 per cent were much improved; 17 per cent were improved; 18 per cent were slightly improved; and 60 per cent unimproved. Of the 105 patients operated upon 30 (29 per cent) patients were paroled. If we omit the patients who showed only slight improvement, 20 per cent of the patients operated upon showed impressive reduction of their symptoms.

There is a definite relationship between operative outcome and preoperative deterioration (Tables III and IV). Among the 21 patients who did not show any deterioration, 62 per cent showed a good improvement. Among the patients who showed some deterioration 21 per cent improved, while among the markedly deteriorated patients only 7 per cent improved sufficiently. The quality of the improvement in the nondeteriorated patient is also different from that seen in the deterio-

TABLE I.—CLASSIFICATION OF 105 SCHIZOPHRENICS USED IN STUDY

Diagnosis	Patients			Degree of deterioration			
	Number	Ages in yrs.	Duration of illness yrs.	None or minimal (1)	Slight (2)	Marked (3)	Very marked (4)
Hebephrenia	21	22–38	8–20	1	1	14	5
Catatonia	22	21–43	3–19	1	6	10	5
Paranoia	25	26–58	3–11.5	3	7	12	3
Pseudopsychoneurosis	21	22–62	4–44	21	0	0	0
Mixed	15	26–57	3–20	4	1	6	4
Simple	1	29	7	0	0	1	0
Total	105			30	15	43	17

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TABLE II.—IMPROVEMENT RATINGS

Diagnosis	Recovered	Greatly improved	Improved	Slightly improved	Unimproved	Total	Parole
Hebephrenia	0	0	1	6	14	21	6
Catatonia	0	0	4	1	17	22	3
Paranoia	0	0	2	5	18	25	2
Pseudopsychoneurosis	1	2	10	5	3	21	15
Mixed	0	0	2	4	9	15	4
Simple	0	0	0	0	1	1	0
Total	1	2	19	21	62	105	30
Per cent total	1	2	17	18	60		29

rated schizophrenics. In the first group we often see a gratifying all around improvement of the patient, in some, up to the point of a completely vanished pathological symptomatology. In the second group, only certain disturbing features of the psychosis are reduced or altered. Many of these patients can be paroled but they are not as well integrated as patients in the nondeteriorated group. We suggest that differentiation be made between a so-called palliative or "administrative" improvement and a "curative" improvement. Deterioration is a formidable barrier to good improvement. In deteriorated schizophrenics most of our patients showed only a palliative improvement.

It will be necessary to compare the topectomy statistics with lobotomy statistics to see if lobotomy accomplishes more or less in such types of patients. In nondeteriorated schizophrenic patients, especially those with obsessive and phobic symptomatology, topectomy

TABLE IV.—IMPROVEMENT RATINGS AND PREOPERATIVE DETERIORATION

Group	Number	Recovered per cent	Much improved per cent	Improved per cent	Slightly improved per cent	Unimproved per cent	Parole per cent
Schizophrenic pseudopsychoneurosis (Deterioration rating = 1)	21	4	10	48	24	14	71
Overt, no or slight deterioration	24	0	0	21	17	62	29
Overt, marked or very marked deterioration	60	0	0	7	20	73	13
Total	105						

TABLE III.—IMPROVEMENT RATINGS IN RELATION TO DEGREE OF DETERIORATION

Degree of deterioration	Recovered	Much improved	Improved	Slightly improved	Unimproved	Total	Parole
None or minimal (1)	1	2	11	7	9	30	19
Slight (2)	0	0	4	2	9	15	3
Marked (3)	0	0	4	12	27	43	8
Very marked (4)	0	0	0	0	17	17	0
Total	1	2	19	21	62	105	30
Per cent total	1	2	17	18	60		29

is quite effective. We believe that with this operation the therapeutic results would be much better if the operation could be done on schizophrenic patients when they have failed with other forms of treatment, but have not yet reached the state of marked deterioration. We should not wait for years to operate on these schizophrenic patients. It should be done at a time when the disorder has not fixed itself too profoundly, when the deterioration is present but not too early, and not without exposing the patient to other therapeutic methods first. Sometimes it is difficult to decide whether or not a patient is deteriorated, especially after the sickness has become chronic. Better criteria of differentiating between deteriorated and nondeteriorated (regressed) patients will be necessary.

Observations on our cases confirm the statements made about lobotomized patients that obsessive, depressive, phobic symptoms are most influenced by the operation. Disorganization features in schizophrenia are also influenced if the patient was not too deteriorated at the time of the operation. Markedly aggressive patients seemingly respond better to lobotomy than to topectomy. Otherwise we

TABLE V.—IMPROVEMENT RATINGS BASED ON SITE OF OPERATION

Site of topectomy	Recovered	Much improved	Improved	Slightly improved	Unimproved	Total
Superior	1	1	3	7	27	39
Orbital	0	0	3	9	15	27
Fronto-orbital	0	1	13	5	20	39
Total	1	2	19	21	62	105
Per cent total	1	2	17	18	60	

have not seen too great a difference between topectomy and lobotomy results. The question arises— Does or does not topectomy produce the same amount of personality damage as does lobotomy? Our clinical impression is that marked alterations in personality, especially the well known apathy, complacency, and emotional dulling, do not occur as frequently and persistently as with lobotomy. Sustained impairment of social sentiments by a careless and uninhibited behavior is not often seen in topectomized patients. How far highest symbolic functions like planning, foresight, and creativeness are impaired is not determined. The clinical impression is that some of these patients show an impairment in this range of highest mental activity and many others do not.

Until today psychological tests have not helped very much in clarifying this important issue. Detrimental personality changes after topectomy are seen more commonly in deteriorated schizophrenic patients than in those who had a relatively well preserved mentality prior to the operation.

It has been claimed that operations on the upper quadrant of the frontal lobe produce different effects from those on the lower quadrant. Our topectomy case material was divided into three groups as Table V indicates. Thirty-nine patients had the superior operations, 27 orbital, and 39 fronto-orbital. This table would indicate that the highest improvement rate was obtained in patients who received the fronto-orbital operation. However, this group contained many more well preserved patients than the other groups. The prognosis of the well preserved patients is better, as it was previously shown, regardless of where the operation is performed. If we correct these figures, paying attention to the factor mentioned, the difference among the results of the three forms of operation is insignificant.

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SELECTIVE CORTICAL UNDERCUTTING

Results in New Method of Fractional Lobotomy

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FOLLOWING the fundamental work of Fulton (1, 3, 4), Moniz and Lima, and Freeman and Watts, prefrontal lobotomy has become well established as a treatment for mental illness. Until 1947 most lobotomists endeavored to sever as many of the frontothalamic connections as possible, varying the plane of section only in an anterior or posterior direction, and little had been done to determine specificity of function of the frontal lobe in man. Recent progress has been made in developing various selective operations in order to permit localization of function and thus limit the personality blunting which has been the inevitable price paid for a complete lobotomy operation. This blunting reveals itself in the higher realms of creative imagination, foresight, ambition, and social sensitivity as stressed by Rylander, and others (6). It is less noticeable when lobotomies are limited to severely deteriorated schizophrenic patients of long standing, but if they are to be applied to the intractable neuroses, affective psychoses, psychalgias,

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TABLE 1.—PSYCHIATRIC RESULTS

	Cases	Undercutting			
		Superior	Orbital	Medial	Standard
Schizophrenia	118	33	28	32	25
Significant improvement		10 (30%)	14 (50%)	16 (50%)	10 (40%)
Marked		5	4	4	4
Home		1	1	4	2
Affective psychoses	17	7	6	1	3
Significant improvement		7 (100%)	5 (100% of survivors)	1 (100%)	3 (100%)
Marked		5	3		1
Home		2	2	1	2
Psychoneuroses	7	2	4		1
Significant improvement		2	4		1
Home		2 (100%)	4 (100%)		1 (but marked deterioration)
Mental defectives with psychoses	4		3	1	
Significant improvement			0	0	
Psychopaths	2		1		1
Significant improvement			1		1
Organic psychoses	2		1		1
Significant improvement			1		0

and addiction tension states, it is imperative that psychosurgery result in no appreciable personality deficit. In striving toward this goal, both psychiatrists and neurosurgeons have been seeking ever more selective methods and locations for operation. This discussion presents the psychiatric end results in 150 patients undergoing the new selective operation called cortical undercutting, first described in 1949 by William B. Scoville (10, 11), neurosurgeon at the Hartford Hospital and assistant clinical professor of surgery at the Yale University School of Medicine. The patients forming the basis of this report were all operated upon by Scoville or in his clinic under his personal supervision. A more detailed report of this material will appear in *American Journal of Psychiatry*.

METHOD AND ADVANTAGES

Selective cortical undercutting is a method of functionally and anatomically isolating various areas of the frontal cortex with preservation of its own and adjacent blood supply, making a line of cleavage with a brain spatula and fine suction tube at the relatively avascular junction of gray and white matter, thus interrupting long and short association fibers to the thalamus and elsewhere. It has certain advantages over other methods of selective lobotomy.

SELECTION AND TECHNIQUE

Three areas of the frontal cortex have been selected in which the undercutting technique was employed. These areas are (1) the superior surface, chiefly in areas 9 and 10 of Brodmann, (2) the orbital surface, and (3) the medial surface including the anterior cingulate gyrus both above and below the corpus callosum. They have been selected because of Pool's results in ablation of the superior surface in man and because of the profound physiologic and emotional changes following ablation or stimulation of the orbital and cingulate areas in animals.

One hundred and fourteen mental patients were subjected to selective undercutting and 33 additional patients to control "standard" lobotomies at two state hospitals (Norwich State Hospital and Connecticut State Hospital); 25 patients at the Institute of Living; 8 at the Hartford Hospital; 3 at the Veterans Hospital, Newington. Sixty-three undercuttings and 15 standard controls were done at the Connecticut State Hospital, Middletown, and 51 undercuttings and 18 standard controls at the Norwich State Hospital.

RESULTS

A. Psychiatric results. The psychiatric results were catalogued under the categories of unimproved, slightly improved, moderately improved, markedly improved, and symptom-free. Evaluation has been made by combining the opinions of the ward attendant, nursing supervisor, physician, and relatives. The psychiatric results of selective undercutting approximate those of the standard control lobotomy group in spite of the fact that undercutting operations interrupt only one-third the amount of cortex interrupted in the standard procedure. The longer 2 year series

of undercuttings at Connecticut State Hospital yielded 60 per cent significant improvement which equaled exactly the results of the standard lobotomy control series at that hospital, and compares favorably with the 64 per cent significant improvement reported in the 3 year over-all report on 450 cases by the Connecticut Lobotomy Committee. The results in the affective psychoses and neuroses (obsessive-compulsive and tension states) have been universally good regardless of the area selected, indicating that complete lobotomies are not necessary. The results in schizophrenia are dependent on the case selection as revealed in the results obtained in 2 state hospitals (Table II), the results being favorable in paranoid schizophrenia in persons having been hospitalized less than 9 years.

TABLE II.—RESULTS IN SCHIZOPHRENICS AT TWO STATE HOSPITALS

Schizophrenia	Cases	Undercutting			Control
		Superior	Orbital	Medial	Standard
Connecticut State Hospital	60	17	15	18	10
Significant improvement		7 (41%)	10 (66%)	13 (72%)	6 (60%)
Marked		5	4	3	3
Home		1	1	4	2
Norwich State Hospital	58	16	13	14	15
Significant improvement		3 (19%)	4 (31%)	3 (21%)	4 (27%)
Marked		0	0	1	1
Home		0	0	0	0

B. Personality results. It can now be said with some certainty that selective fractional undercutting causes far less personality deficit than does the complete lobotomy procedure. This has been repeatedly observed and commented upon by ward personnel, physician, and relatives. Drs. Francis Grant and Nulsen at the University Hospital, Philadelphia, made similar observations after performing superior surface undercutting on 12 nonpsychotic patients for intractable pain. Undercutting of the orbital surface appears to cause the least change in personality of all operations, the patient appearing entirely unchanged in the early days after operation. This result applies both to the personality and to the psychosis. Therapeutic effects on the psychosis then become gradually apparent over the ensuing weeks. There is no visible apathy and occasionally considerable gaiety. There may be some motor hypermotility and restlessness continuing for several weeks. Undercutting of the superior surface causes an appreciable but temporary blunting and apathy of personality similar to, but to a much less degree than that after a standard lobotomy. There is more likely to occur an abrupt relief from psychotic symptoms, although the end results in both superior and orbital surface undercuttings become approximately equal after 3 months' time. Undercutting of the medial-cingulate gyrus surface causes temporary drowsiness and apathy with little apparent early therapeutic benefit and the patient is physically more "knocked out" than in the 2 other operations. There are no marked personality changes. Its therapeutic effects on psychoses are hard to evaluate because of the apparent large number of early failures which have shown late improvement. Hence, final evaluation of this last procedure is yet to be made.

C. Complications. Few relapses after the first postoperative month have occurred in patients followed up to 2½ years. With few exceptions, after the first month the trend has been toward further improvement from month to month and even year to year. Postoperative epilepsy occurring more than 1 week postoperatively has been noted in 6.6 per cent of patients subjected to the cortical undercutting operation. No prophylactic anticonvulsant medication has been used and only rarely has a patient had a second seizure after receiving such medication. There has been a 1.4 per cent mortality, both patients having delayed hemorrhages. There have been no infections.

D. Physiologic changes. Physiologic changes have been largely absent except for occurrence of nausea and vomiting and temporary somnolence in medial surface-cingulate gyrus undercutting. Henry has demonstrated a dampening of voltage amplitude alternating with periodic regular bursts of waves in electricocortigrams taken from the undercut cortex and Meyer and McLardy of London have found little difference in the cytoarchitecture of the undercut cortex from that seen following standard lobotomy.

CONCLUSION AND SUMMARY

1. Complete lobotomy causes too much blunting of the personality to warrant its further use except in severely deteriorated psychotic patients.

2. Selective cortical undercutting is presented as a new method of fractional lobotomy and offers certain technical advantages over other methods in precision, preservation of adjacent blood supply, facility and accessibility.

3. A sufficient number of undercuttings have now been done to permit specific recommendations for its therapeutic use.

4. The results of undercutting indicate that there is little specificity of the frontal lobes in their effect on psychoses but definite specificity in their effect on personality. The psychoses are favorably affected by quantitative isolation of any area of the frontal lobes. The personality is unaffected and shows little, if any, blunting following isolation of the orbital surface and a definite blunting upon isolation of the superior surface, similar but to a less degree than that found in a standard of lobotomy.

5. There is more apparent personality deficit in nonpsychotic than in psychotic patients following any type of lobotomy. Hence, only fractional lobotomies should be used in patients suffering from mood disorders, neuroses, or pain.

6. Undercutting of the orbital surface appears to be the ideal operation for psychoneuroses and milder mood disturbances because of the almost complete absence of personality change.

7. Undercutting of the superior surface or of the orbital surface is recommended for the schizophrenic and severe affective psychoses, the results being roughly equal to those obtained in standard lobotomy with significantly less personality deficit.

8. Pain, if accompanied by addiction, psychalgia or excessive anxiety, responds well to undercutting of the superior surface.

9. Undercutting of the medial cingulate gyrus surface is technically more difficult and dangerous with inferior early and possibly equal late results, making final evaluation difficult.

10. Certain cases showing an inadequate response to selective undercutting can be converted to a more complete lobotomy as a second stage procedure.

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EVALUATION OF THE RESULTS OF THALAMOTOMY AND OTHER SURGICAL PROCEDURES FOR THE RELIEF OF PSYCHOSES

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IN an evaluation of the results of psychosurgical procedures one should consider not only the beneficial effects but also the undesirable sequelae and thus attempt to decide whether the possible benefits are worth the price paid in disturbance or loss of cerebral function. We have studied 3 types of thalamotomies: (1) dorsomedial thalamotomy, that is, a bilateral lesion of the dorsomedial nuclei; (2) anterior thalamotomy, a bilateral lesion of the anterior nuclei; and (3) hypothalamotomy, a bilateral lesion of the lateral part of the posterior hypothalamus.

Our experience with anterior thalamotomy is limited to single instances with only brief periods of observation so that this survey will deal chiefly with dorsomedial thalamotomy alone or combined with hypothalamotomy.

Qualitatively such lesions may give results similar to those obtained with the various frontal lobe operations, namely, relief from tension and anxiety states, obsessive thinking, diminution or elimination of agitation, aggressiveness and compulsive behavior. The emotional reaction to hallucinations and delusions may be reduced, and these symptoms eventually may disappear. Rorschach studies also seem to indicate that patients successfully operated upon are no longer so upset by emotionally charged situations as they were before operation.

Regarding a quantitative statistical evaluation, it should be emphasized that only preliminary conclusions can be drawn since the number of cases (56) is too small and the duration of the observations (up to 3½ years) too short to warrant definite conclusions. In these 56 cases 79 operations were performed; 2 patients died on account of intracerebral hemorrhages. This gives a case mortality of 3.6 per cent and an operative mortality of 2.5 per cent. The patients were operated upon by, or in his clinic under the personal supervision of, Henry T. Wycis, associate professor of neurosurgery, Temple University School of Medicine, neurosurgeon, Temple University Hospital, and associate neurosurgeon, Philadelphia General Hospital.

Our material comprises chiefly chronic cases of schizophrenia and also of manic-depressive and of involutional psychosis, and of severe psychoneurosis (obsessive-compulsive and anxiety states.) Only such patients were accepted for operation in whom the usual psychiatric therapeutic armamentarium including the various shock therapies proved ineffective.

In Table I the results as to social recovery are grouped according to the principles adopted at the First International Congress for Psychosurgery. Group A consists of patients who returned home with nearly full working capacity; group B, patients who were able to return home but whose working abilities were diminished; group C, patients who remained hospitalized but are relieved of some of their symptoms and are more easily manageable; group D, patients who are not improved; and group E, patients who were made worse. In subgroups B_t and C_t are cases in which improvement was only temporary. Only those patients are tabulated who have been observed for more than 6 months. Our first 3 patients are excluded, since only single lesions of a few millimeters in diameter were produced because we dealt with a new method.

In approximately ¼ of the cases there was a definite improvement (groups A and B); in another fourth the patients became more easily manageable, while ⅕ were only temporarily improved and about ⅓ were not benefited.

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TABLE I.—RESULTS IN 43 CASES OBSERVED FOR ½ TO 3½ YEARS AFTER THALAMOTOMY

	No. of cases	Per cent	Total per cent
Group A	7	16.3	
Group B	4	9.3	25.6
Group C	11		25.6
Group B_t	4	9.3	
Group C_t	4	9.3	18.6
Group D	13		30.2
Group E	0		0.0
Total	43		100.0

The undesirable by-effects and sequelae of thalamotomy are distinctly less pronounced than those following operations on the frontal lobes. Memory defects, disorientation particularly for time, diminution of initiative, and slowness of response were present for some weeks after operation. In 3 schizophrenic patients there was a transient increase of sexuality and aggressive behavior lasting a few weeks. Undesirable effects of long duration appeared in single instances only, namely, memory defects of several months' duration and reduction of initiative. Untidiness of personal appearance was observed in a woman who had been subjected to frontal lobotomy preceding the thalamotomy suggesting the possibility of a combined effect of the two operations. In none of our cases could we observe such sequelae of frontal lobotomy as facetiousness, lack of tact or discipline, distractibility, profanity, outbursts of temper, or childish behavior.

A statistical analysis of the results obtained with the Wechsler-Bellevue intelligence test failed to show significant alterations of the subtest scores, the verbal I.Q., the performance I.Q. or the full I.Q. A comparison of preoperation and postoperative Rorschach studies failed to show signs of increased organic involvement after thalamotomy. Operative procedures on the frontal lobe less radical than lobotomy such as undercutting or transorbital lobotomy also show less undesirable personality changes than the standard lobotomy. It seems, however, that operations limited to cortical lesions produce extensive cortical scars and thus cause postoperative epilepsy in a considerable percentage of the cases (e.g., 16 per cent after topectomy). It seems, therefore, of interest that we observed only once an epileptiform seizure that followed an orbital infection in a patient several weeks after reoperation (hypothalamotomy). In none of our cases was more than a single seizure observed. Electroencephalographic studies also failed to show the development of a convulsive hyperreactivity.

While a transorbital leucotomy can be performed in a few minutes, thalamotomy, the stereotaxic method being used, demands careful application of the apparatus for the preoperative x-ray studies as well as for the operation, thus several hours of patient work are required. Is thalamotomy, therefore, worth the effort? This question should be answered in the affirmative in view of the fact that this procedure may produce beneficial effects with minimal neurological and psychiatric by-effects.

For a comparison of the effects of the frontal lobe operations and of thalamotomy, cases are of interest in which one of these 2 groups of operations was followed by no improvement or only a transitory effect, and in which at a later date the other type of operation was performed. We are able to report 6 such instances. In 1 case an unsuccessful thalamotomy was followed by a transorbital leucotomy, in a second by a standard lobotomy. In 3 instances thalamotomy was performed in patients who had not been improved by frontal lobotomy and in a sixth instance a combined thalamotomy and hypothalamotomy were performed after a transorbital leucotomy had produced improvement for a few months only. The first case was a patient with obsessive-compulsive neurosis operated upon at a time when we substituted high frequency electric coagulation by electrolysis and therefore produced only a very small electrolytic lesion. We did not have a chance to produce the subsequently developed type of large electrolytic lesions since a transorbital leucotomy was performed on this patient 2 months after the thalamotomy, apparently with favorable results. In a second patient, a severe anxiety state (borderline schizophrenia), neither extensive lesion of the dorso-

medial nuclei nor a subsequent standard lobotomy, performed in another hospital, were able to reduce the patient's complaints.

In a third patient with severe obsessive-compulsive neurosis uninfluenced by prefrontal lobotomy, the obsessive thoughts and compulsive acitivity were eliminated or definitely reduced by the subsequent thalamotomy. A fourth patient, with a severe anxiety neurosis that had been refractory to 2 standard lobotomies, was definitely improved by thalamotomy so that he is able to work successfully as a barber. The fifth case is a paranoid schizophrenic who had to be reinstitutionalized because of aggressive sexual behavior a few months after transorbital leucotomy had produced a transient remission. A combined thalamotomy and hypothalamotomy made the patient more quiet and better manageable. The time elapsed since this operation is, however, too short to arrive at a definite conclusion. The same applies to the sixth case, a schizophrenic unrelieved by frontal lobotomy, in whom recently a combined anterior and dorsomedial thalamotomy was performed.

These are, of course, single instances that do not permit definite conclusions. They seem to show, however, that at least in some cases thalamic procedures may be of therapeutic benefit to patients who were not or only temporarily improved by frontal lobe operations.

A more valid quantitative comparison of the various frontal lobe operations and the thalamotomies than here presented could perhaps be obtained if the uncertainty due to the variability of postoperative environmental conditions could be eliminated. This would be possible if in an institution a sufficient number of patients would be selected according to standardized, uniform indications, and this material would be divided into several groups, and each group be subjected to another type of operation and be observed under similar conditions postoperatively. As long as such material is not available, it would seem that, apart from the incidence of gross by-effects and neurological complications such as epileptiform convulsions, only a rather gross comparison of the thalamotomies and the other psychosurgical procedures is possible.

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RETROPUBIC PROSTATECTOMY

WHILE observing a prostatocystectomy after the technique of Hinman, a British urologic surgeon was impressed with the excellent visualization of the prostate gland afforded by the operation. He decided to try this approach for prostatectomy and in August, 1945 Mr. Terence Millin performed the first retropubic prostatectomy and during the same year he described the operation and reported his experience in twenty cases.

The procedure represented a bold departure from the time-honored surgical avoidance of the space of Retzius based largely on the fear of infection in this area. Two years later the American Urological Association invited Mr. Millin to present a paper on the subject at their annual meeting in 1947 at which time he had performed somewhat more than 400 retropubic prostatectomies. His contribution to the program was very favorably received and since then this new approach to the prostate gland has been extensively employed in this country as well as abroad. Sufficient data have accumulated in published reports of series aggregating nearly 2,000 cases to warrant deductions regarding the indications, advantages, disadvantages, functional results, complications, and mortality rate of this relatively new procedure.

As a rule the operation consists of a low transverse incision which includes the sheath of the rectus muscles. The latter are separated in the midline and are mobilized a distance of 5 or 6 centimeters superior to the transverse incision and inferiorly as far as the level of the symphysis pubis, which permits their gentle retraction. The anterior wall of the bladder is retracted posteriorly and cephalad and by blunt dissection the anterior surface of the enlarged prostate gland is separated from the posterior aspect of the symphysis pubis with the patient in the Trendelenburg position. The surgeon is then enabled to visualize the rich venous plexus of Santorini coursing from below upward over the anterior aspect of the gland. Two rows of hemostatic sutures are placed transversely, between which the prostatic capsule is incised 1 to 2 centimeters below the junction of the bladder with the prostate gland, thus providing a means of preventing undue loss of blood from this exceedingly vascular area. The cleavage plane between the true and false capsules of the gland and the whitish adenofibromatous tissue is readily recognized and is entered by dissection with spreading scissors directed caudally and laterally. Improved visualization of the area is attained in obese subjects by displacing the preprostatic fat laterally and packing it away with gauze strips. A finger is then inserted

into the cleavage plane and the hypertrophied lateral lobes are enucleated first laterally; the dissection is then carried caudally until the apex of the gland is reached. By gentle retraction of the prostate cephalad and the inferior margin of the capsule downward, the apex of the gland is exposed at its junction with the urethra where it is severed with scissors under direct vision. In very large glands the lateral lobes are thus mobilized and removed separately, which prevents extensive tearing of the prostatic capsule laterally. Vulsellum forceps are employed for upward traction and the gland is thereby reflected upward and, after enucleation of the subtrigonal or subcervical portions, its juncture with the region of the trigone is secured by hemostats and the adenofibromatous mass is finally removed, employing either scissors or the scalpel for its severance from the posterior margin of the vesical neck. At this juncture all bleeding points may be secured under direct vision by electrocoagulation and any tags or small adenomas remaining are easily visualized and removed separately. No other approach to the prostate affords such excellent visualization of the prostatic cavity. At this time it is well to seize the posterior lip of the vesical neck with a hemostat and excise a V-shaped wedge which has been found to insure against subsequent vesical neck contracture. An exploring finger is inserted into the bladder with special reference to the detection of any vesical calculi, diverticular orifices or possibly a neoplasm. Small stones, if present, may be grasped with forceps and removed through the vesical neck, or larger ones may be crushed and removed in fragments. It is also possible to perform an extravesical diverticulectomy at this time. The author has accomplished this in two cases by inserting a bag type of catheter through the vesical neck into the diverticulum with inflation of the bag sufficient to convert the sac into a semisolid tumor, thus facilitating its mobilization and removal.

As soon as satisfactory hemostasis has been attained, a No. 24 F. catheter is passed per urethram with the proximal tip directed through the vesical neck into the bladder. The author prefers a Foley type of catheter with only enough fluid in the bag to render it self-retaining. A thin layer of oxidized gauze occasionally is tucked about the bag within the prostatic cavity in order to control any unusual oozing of blood from this area. In the majority of cases, however, this is unnecessary. A watertight closure of the prostatic capsule is then effected by a double row of chromic No. 1 catgut, the inner one of which is interlocked. The importance of a watertight closure cannot be overemphasized as it insures against extravasation of urine into the retropubic space which, of itself, would constitute fertile soil for infection. Furthermore, leakage of urine from the capsular incision would predispose to a persistent urinary fistula. Inasmuch as urinary infection is almost universally present in these cases, one may consider himself operating in a potentially infected field; therefore, after closure of the prostatic capsule, the incision is repeatedly flushed with sterile saline followed by the local application of a sulfonamide. Upon removal of the retractor the recti muscles fall together and are approximated with two or three interrupted sutures of plain No. 1 catgut, after which the transverse incision in the sheath of the rectus is closed with interrupted sutures, preferably of cotton or silk, and the skin is closed also with interrupted sutures. One rubber tissue drain is left in the region of the prostatic capsule and is shortened the third day and finally removed the fourth or fifth day. If the urine is clear or only pink on the second day, the catheter is removed. In the majority of cases it can be removed by the third day, after

which the patient is allowed to be up and about and will pass urine without leakage from the incision.

What are the advantages of this new surgical approach for the relief of prostatic obstruction? The operation is based on sound anatomic principles and provides a direct and simple approach to the obstructing gland; excellent visualization of the prostatic cavity is afforded which definitely contributes to more efficient hemostasis and more accurate removal of all obstructing tissue; there is no urinary leakage from the incision which is conducive to primary healing and a remarkably brief period of hospitalization, usually terminating by the eighth or tenth day; the retropubic approach can be used to advantage in early malignancies of the prostate, affording as radical an extirpation as by the perineal route with the removal of the entire capsule and seminal vesicles with less risk of injury to the rectum and vesical sphincters; there is definitely less shock and the patients are more comfortable during their immediate convalescence than after either suprapubic prostatectomy or transurethral resection when dealing with large glands; lastly, the immediate and remote functional results are highly satisfactory, the incidence of serious complications is relatively infrequent and the mortality rate is low. This is evidenced by two hospital deaths among the first 116 retropubic prostatectomies (1.7 per cent) performed by the author, his associates and resident staff. The average age of this group is 69.5 years and the average weight of the glands removed in this series is 75.6 grams, the largest weighing 250 grams.

The chief indication for employing the retropubic approach for prostatectomy centers about the size of the obstructing prostate. Formerly, the author subjected nearly all patients with prostatic obstruction, whether benign or malignant, to transurethral resection. It has been learned from experience, however, that if one contemplates the removal of 50 or more grams of tissue for relief of obstruction in benign cases, it is probably better to employ enucleation of the adenofibromatous mass rather than to depend upon the removal of the obstruction in small segments by the transurethral approach. In observing this rule it has been found in recent years that about 75 per cent of patients with benign prostatic obstruction can be dealt with very satisfactorily transurethrally and the remaining 25 per cent are subjected to retropubic prostatectomy.

The more common complications which occur with prostatectomy, regardless of the choice of approach, are epididymitis, pyelonephritis, secondary hemorrhage and late vesical neck contracture. It is worthy of note, however, that these complications have occurred relatively infrequently and that, furthermore, there has not been an instance of urinary incontinence nor urinary fistula. Sexual power is unusually well retained and has actually been reported improved in between 15 and 20 per cent of our cases.

The occasional occurrence of osteitis pubis has proved to be the most important deterring factor. The onset of the complication varied from two to five months following operation, averaging two months. This complication occurred in thirteen cases of a group of 80 in the author's experience and proved to be serious in three with periods of disability varying from two to ten months. The onset is characterized by moderate pain and tenderness in the region of the symphysis pubis with the pain radiating later into the region of the adductor group of muscles on the inner aspect of the thighs. Severe paroxysmal pain in this region may be precipitated by any movement of the pelvis or lower extremities and the patients lie in bed quiet-

ly, fearing to move the body or extremities. There is no external evidence of an inflammatory process and aspiration of the region of the symphysis with culture of the material has yielded no positive information from a bacteriologic standpoint. Most of the incisions had healed per primam. Roentgen examination of the region of the symphysis in the early stages is essentially negative but later there may be evidence of rarefaction of the pubic bones with increased density of the margins at the symphysis with widening of the space between the rami in the midline. In one of the cases the incision reopened several months following operation and discharged pus for several weeks but finally healed and at the end of ten months the patient was able to walk comfortably and bladder function was satisfactory. The results of treatment by chemotherapeutic agents and antibiotics have been disappointing. Rest in bed is essential and local heat is productive of comfort. Vitamin B-1 in massive doses apparently has been of some benefit in those cases in which obturator neuritis is in evidence. Deep roentgen ray therapy so far has proved to be the most effective single measure toward controlling or shortening the course of the disease. One of the author's cases responded favorably to only 300 R units and was able to walk out of the hospital unassisted ten days after treatment was instituted.

After this distressing complication had occurred in several cases, the operative technique was closely scrutinized and certain changes were inaugurated. Fortunately the complication has not occurred during the past two years in a series of more than 100 cases. I refer to the more gentle retraction of the rectus muscles with less tension on their attachment at the symphysis pubis, and the avoidance of electrocoagulation of the veins comprising the plexus of Santorini which formerly were grasped by hemostats and electrocoagulated. These are now secured by hemostatic sutures. Formerly, the prostatic capsule was incised with an electric scalpel. It is now incised with an ordinary scalpel between hemostatic sutures. Meticulous care has been exercised to avoid traumatizing the periosteum of the pubic bone, either by the prick of a needle or with heavy retraction, and it is believed that these precautions, together with the avoidance of undue heat in this area from electrosurgery, have definitely contributed to the elimination of osteitis pubis as a complication.

It may be definitely stated that retropubic prostatectomy has been performed by many urologic surgeons in a sufficient number of cases and with results observed over a sufficiently long period to warrant the conclusion that through merit it has earned recognition as a standard procedure for the relief of prostatic obstruction along with the other time-honored approaches of suprapubic, transurethral, and perineal prostatectomy.

THOMAS D. MOORE.

THE MEDICAL CARE OF VETERANS

IT is mandatory that the current program of veterans' medical care be reviewed in a critical and dispassionate manner. It is, furthermore, important that this analysis take into account not only the present situation but also future developments which logically must follow. No more fitting time could be selected for such a study than the present when we are on the verge of another mobilization of a large armed force and the creation of additional millions of veterans.

What is our nation's medical obligation to those of us who have served her in this fashion? First, and incontrovertibly, there is

the obligation we owe to every citizen, rich or poor, inhabitant of rural or urban area, veteran or nonveteran, that within the limits of possibility no one be denied adequate medical care. We recognize and indeed cherish this responsibility even though it may not be universally achievable at the moment. Are there additional obligations to veterans? I believe that there are. Looking at the matter from a purely ethical-patriotic point of view one might answer this question in the negative on the basis that no higher privilege is afforded a citizen than to bear arms in the defense of his country and, hence, that no special considerations are due other than provision of adequate pensions for those who, by virtue of such service, have lost or had significantly reduced, the capacity to earn a livelihood. There are a great many of us who do look upon our period of military service in this manner. Nevertheless, I believe it to be the overwhelming sentiment of our citizens, and rightly so, that those who have become physically handicapped as a result of such service receive the finest of medical attention not only while in uniform but that for the remainder of their lives they receive the same fine medical care for any complaints which may result from service-connected disabilities. In addition, they must know that these medical services are theirs by right and not by beneficent gratuity.

Beyond that, I am convinced that there cannot be universal approval for the current willy-nilly dispensation of medical care for nonservice connected disorders to rich and poor alike. To be sure, according to the law, such service is to be rendered only to those who cannot afford other medical care. But it is a well known fact that the veteran's affirmation of his poverty is never challenged. This practice is not only condoned; it is a matter of general policy. There are cogent reasons for doubting the wisdom of this policy. In the first place it is dishonest. It makes a dishonest supplicant of each applicant for care whose finances are better than affirmed. Furthermore, it involves all of us as participants in our Government in a policy of deceit. This can only lead to moral deterioration. If nonservice connected illness is to be a responsibility of the Veterans Administration, to be administered to millionaire as well as pauper, let us write it into the law and end this dissimilation.

There are, however, other reasons for doubting the wisdom of this policy. There is little or nothing to commend the viewpoint that the giving of service in arms to one's country entitles one forever afterward to medical care for any illness or physical disability which may be his lot. I am convinced that a majority of our population in general and a majority of us veterans in particular are in agreement in this respect. It is easy to see in what direction we are led by the policy of administering medical care to each veteran for any complaint which may arise during the days of his life. There are at present roughly some 15,000,000 veterans. The most optimistic cannot fail to foresee many millions more created by the necessary expansion of our military forces. Consideration of this huge segment of our population as entitled to special privileges of hospital and medical care must of necessity eventuate in a spirit of unrest. In addition, it is a matter of practical experience that the dispensation of government benefits on such a grand scale leads ultimately, even when not sought by the beneficiary, to even more costly and less deserved gratuities. The recently enacted law which makes service-connected any case of tuberculosis developing within five years after discharge is a case in point. Is there not a real likelihood that some ill-advised though per-

haps beneficent lawmaker, or some obviously irresponsible vote-seeker, may succeed in bringing about an extension of this period to ten years, or twenty? If each veteran is to receive medical care for any accident or disease to which he may be subject, may not a similarly kindly or callous legislator be successful in bringing it about that the veteran's spouse enjoy the same prerogatives—or his children? The ultimate result staggers the imagination. This is not the time to consider the pros and cons of government-dispensed medical care in contradistinction to the traditional manner of American medical practice. It is, however, a truism that were the former preferable it should be made available to the population at large and not simply to a segment of it.

It is a matter of practical necessity not only to use wisely the nation's financial resources, but also to put to best use its hospital facilities and its medical manpower. It has been suggested, without any significant discernible effect, that the veterans' hospitals and the hospitals of the army, navy, and public health service be used more or less interchangeably for military personnel and veterans in order to avoid waste and reduplication. The possibility should be considered that this suggestion only adds confusion without contributing to any fundamental solution. Those in the armed forces are military personnel and veterans are civilians. Would it not perhaps be wiser to consolidate and unify the medical services in the armed forces on the one hand, and, on the other, to link more closely the care of veterans to the care of the remainder of the civilian population? Is it indeed unreasonable to consider the advisability of arranging for the care of veterans in ordinary civilian facilities, rather than to continue to expand the program of providing independent veterans' hospitals?

Already the Veterans Administration has tried, and as far as I know found satisfactory, the use of civilian rather than full-time veterans' personnel and civilian hospitals rather than veterans' facilities. First, many individuals to whom veterans' hospital care is not readily available have been authorized to obtain such care as is required from civilian doctors and in ordinary civilian installations. Secondly, the Veterans Administration has had as the backbone of its service program the use of civilian consultants and attending physicians and surgeons. And finally, in the hospitals under the direction of deans' committees of medical schools—installations the conduct of which can be pointed to with particular pride—all aspects of professional care have been delegated to the appropriate members of the medical school staffs. It would not appear to be risky to say that no aspect of the wide scope of veterans' service has been more uniformly successful than these deans' committee installations. Would it be wise, perhaps, to extend the scope of such collaborative efforts? Would patients and the nation not be served as well or better if the medical care of eligible veterans were entrusted to the best of existing civilian hospitals rather than to continue to attempt to build, equip, and staff more and more veterans' facilities? Were there any merit in such a consideration its practical implementation would appear to be entirely feasible. The Veterans Administration could negotiate arrangements for such care on the basis of some equable financial compensation. Perhaps if some uniform cost-accounting system were mandatory, the institution's per diem patient cost would be a satisfactory basis. Only hospitals meeting the very highest standards need be considered for such collaboration. Undoubtedly most of these institutions would require financial aid in expanding their facil-

ities to meet this added responsibility. Direct grants in aid for such programs of expansion have good precedent. Civilian personnel participating in the care of the veterans might continue to be recompensed much as is customary in the hospitals of the Veterans Administration at the present time. It is difficult to visualize that such a program would result in inferior care or prove more costly than that currently in practice.

Our democratic way of life provides room for doubt. It encourages inquiry into the wisdom or improvidence of current practice. It demands clear planning for the future. No individual veteran and no veterans' organization can doubt the earnest interest of American medicine in their problems in peace and in war. No physician can doubt the sincerity, enthusiasm and energy with which the stupendous problem of the care of veterans has been tackled by those charged with this responsibility. All must be in agreement that only benefit can result from an honest effort to direct the course of veterans' medical care along the best lines.

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THE PROBLEM OF THE PRESIDENT'S BULLET

ROBERT W. PRICHARD, M.D., and A. L. HERRING, JR., M.D., Boston, Massachusetts

IN the early morning of July 2, 1881, James A. Garfield, twentieth President of the United States, entered the old Baltimore and Potomac railroad station in Washington, D. C., to board a train for a reunion at his alma mater, Williams College, in Williamstown, Massachusetts. The Presidential party, consisting of friends, cabinet members, and aides-de-camp, had entrained earlier, and the Chief Executive was accompanied only by the Secretary of State, James G. Blaine, and a detective. Suddenly, from behind the right side of the door by which they had entered the station, stepped Charles Guiteau, a psychotic individual of confused motives, to fire twice at Mr. Garfield's back from a distance of twelve feet.[1] The first shot passed through the right sleeve of the President's coat, inflicting only a slight wound. The second entered the back of the lower thorax on the right. As an officer seized the assassin, and Blaine turned to do likewise, the President slumped to the floor. Within the hour he was attended by a corps of physicians, and the problems of his care were destined to be the concern of the entire nation for seventy-nine anxious days, until his death on September 19, 1881 (5,6,7,10).

At the time of the shooting, Garfield had been in office but four months. He was a man who was noted for his lack of enemies, and enjoyed the respect of even his most determined political opponents. He was idolized by the public as an example of the American success story, having been born in a log cabin of poor parents, and through industry and perseverance, had won the highest office in the land. The day of his death was the 18th anniversary of his promotion to Major General for conspicuous gallantry in the field at Chickamauga, a date which he is said to have regarded with foreboding. The medical profession was already in debt to Garfield. While in the Senate he had vigorously campaigned for funds to underwrite the monumental *Medical and Surgical History of the War of the Rebellion*, and in his speeches in its behalf showed an understanding of the profession rare among laymen.

Immediately following the shooting and the seizure of Guiteau, the President lay upon the the floor of the station. He was nauseated and vomited several times. Approximately five minutes after the shooting Dr. Smith Townshend, the District medical officer, came to his aid, having been summoned from the vicinity. He stated

From the Laboratory of Pathology, New England Deaconess Hospital, Boston, Massachusetts.

[1]His weapon was a five-chambered .44 caliber revolver of the English "bulldog" pattern. A similar gun, tested at Guiteau's trial, put a bullet through a two-inch plank at 100 feet.

that the President was in a faint, from which he recovered after the administration of brandy and ammonia. His only complaint was of severe pain and tingling in his right foot, and he was able to turn over promptly when Dr. Townshend requested that he do so. The crowd pressed about them, and it was necessary to place the wounded man on a mattress, and to carry him to the second floor of the station, where numerous other physicians soon came to offer their help (2, 7).

After the President was established on the second floor, Dr. D. Willard Bliss, a prominent local physician, assumed charge of the case. The President turned onto his right side and his back was bared for examination. An oval hole was present near the right costal margin, four inches to the right of the vertebral spines. Dr. Bliss inserted a Nélaton probe, first to the left, where it met only bony resistance, and then to the right, where it passed with relative ease. The direction of the probe was on a line which, projected on the anterior abdominal wall, would have come out approximately four inches to the right of the umbilicus. Dr. Bliss felt that the probe was then in a cavity. He removed the probe and inserted his little finger, and finding nothing helpful, employed a flexible silver probe which also provided no information. His examination finished, Dr. Bliss called a brief meeting of the physicians present, and ordered the patient removed to the White House. During this examination and conference the President was pale, sweating, and continued to complain of pain and tingling in the lower extremities. His pulse was 120, and his respirations were 8 to 10 per minute (2, 7).

As the President lay in the Executive Mansion, the nation, sensitized by the tragic death of President Lincoln only sixteen years previously, reacted with a sense of deep despair. Telegrams poured in from all civilized nations. Mrs. Garfield rushed to Washington from the New Jersey seacoast, where she was recuperating from a long illness. The physicians felt that their illustrious patient was at death's door. Signs of shock persisted, and an area of dulness was present over the right lower thorax. Morphine was administered several times, and in the late afternoon the President was catheterized. The Surgeon-Generals of the Army and Navy, J. K. Barnes and P. S. Wales, were in attendance, as well as Drs. Robert Reyburn, and N. S. Lincoln of Washington, and Surgeon J. J. Woodward, U.S.A. Dr. Wales probed the wound manually and declared that his finger had passed into the substance of the liver. By 10:00 p.m. the patient's pulse was 158, his temperature 96.5 degrees and the respirations 35. He was not expected to survive the night (2, 7, 9).

The morning after the shooting the consultants assembled again, and found their famous patient much better physically and mentally. The vital signs showed a trend toward normal, both bowels and bladder had functioned, and Dr. Bliss felt impelled to reorganize his staff. Dr. Lincoln, Dr. Wales, and Dr. Townshend were dismissed. Dr. D. Hayes Agnew of Philadelphia and Dr. Frank A. Hamilton of New York were called in consultation, both arriving on July 4.

During the weeks that followed all discussions, consultations, treatments and prognostications concerned the path of the bullet and its place of lodgement. The initial opinion of the attending physicians held that the course of the bullet was to the right of the wound entrance and downward, probably passing through the edge of the liver, and that it had come to rest in the anterior abdominal wall, at or below the umbilicus. The consultants from New York and Philadelphia also probed, with instruments and manually, and concurred in this opinion. Since no signs of injury to the abdominal viscera manifested themselves, it was felt that no active treatment, other than to the external wound, was indicated.

The pain in the feet which the President complained of immediately following the shooting persisted and became more widespread during the early part of his course. There was both pain and hyperesthesia extending up both extremities to the lower abdominal wall, without local signs. The right side of the scrotum was hyperesthetic, the left side normal. There was no paralysis or muscular weakness. These symptoms were treated with local heat and opiates. After several weeks they diminished, and disappeared at an unstated time (2, 3, 7, 10).

While the doctors entertained the probability that the ball had lodged somewhere in the abdomen, the general public argued the point with spirit. Reyburn states that bushelbaskets of mail came daily to the White House, instructing the medical staff on various theories of treatment. One writer enclosed plans for a suction machine which he felt could be used to draw the bullet from the wound. Another suggested that the President's body be inverted for several hours, to allow the bullet to gravitate downward. The heights to which these discussions rose are exemplified by a letter quoted in the Washington *Evening Star*, in which an Annapolis man stated that the bullet was in his possession (7, 10).

On July 26, twenty-four days after the shooting, Dr. Agnew made a thorough exploration of

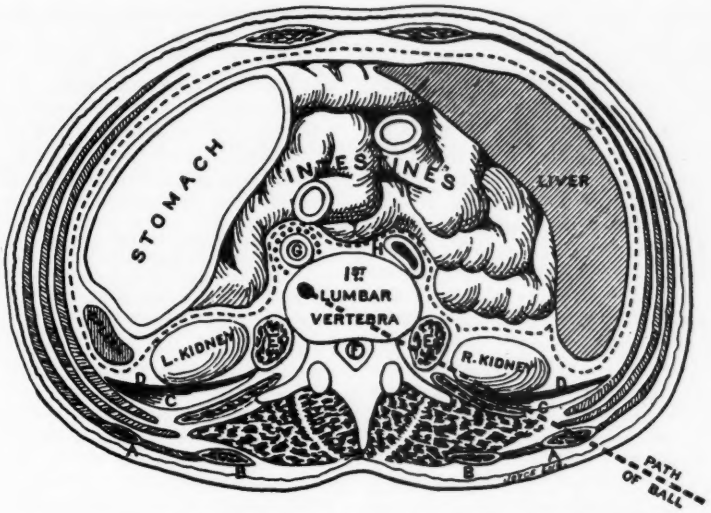

Diagram prepared by Dr. Frank Baker on July 7, illustrating his diagnosis of the track of the bullet. *A*, Eleventh rib; *B*, twelfth rib; *C*, pleural cavity; *D*, diaphragm; *E*, psoas muscle; *F*, spinal cord; *G*, aorta surrounded by solar plexus; *H*, vena cava. The dotted line represents the peritoneum.

the external wound and removed several splinters of bone. On July 27 Dr. Hamilton said, "The conduct of the Surgeons who have managed the case from the beginning to end, has been in my opinion, correct. It will bear the severest scrutiny of experts in this department of Surgery." On the same day he told an *Evening Star* reporter that he "had a suspicion, founded upon a good deal of evidence, that the ball was in the right iliac region, not far above the right groin." It was felt that a rib had deflected the bullet downward and to the right, accounting both for the bone fragments and the entrance of Dr. Wales' finger into the liver. During these maneuverings, the President maintained good spirits, and was confident of recovery, although there were intermittent periods of fever and collapse. The wound was draining what the physicians termed "healthy pus" (10).

To leave no stone unturned, the surgeons availed themselves of other branches of scientific endeavor, even as today. The renowned Alexander Graham Bell volunteered to come from Baltimore with his "induction balance," to attempt to locate the vanished ball (4). He and his assistant, Mr. Sumner Tainter, first tried it on several veterans at the Washington Old Soldiers Home whose bodies contained bullets of known location, and successfully located them. On July 27 they tried it on President Garfield, but later found that there was a defect in the circuit. On August 1, almost a month after the shooting, one of the medical bulletins contained the following statement:

"Under the supervision of the attending surgeons, Professors Bell and Tainter made another application to the patient's body of the electrical apparatus known as the induction balance, with a view to completing the tests of last week, which were not entirely conclusive, and ascertaining definitely and certainly, if possible, the location of the ball. Professors Bell and Tainter had been almost constantly engaged for two weeks in experiments with the induction balance, and have made several modifications and improvements, which add greatly to its efficiency. They tried this improved apparatus upon the President's body for the first time last week, and although it indicated faintly the location of the ball, it was found afterward to be slightly out of adjustment, and the experiment was not regarded as perfectly conclusive. The results of this morning's tests, however, are entirely satisfactory, both to Professors Bell and Tainter, and to the attending surgeons, and it is now unanimously agreed that the location of the ball has been ascertained with reasonable certainty, and that it lies, as heretofore stated, in the front wall of the abdomen, immediately over the groin, about five inches below and to the right of the navel."

Treatment progressed as before, with enlargement of the primary wound, incision of satellite abscesses, insertion of drainage tubes and lancing of numerous "acne pustules" which appeared in several locations over the President's body. A

parotid swelling developed, became fluctuant, and was incised and drained without anesthesia, other than local phenol spray. This abscess later drained spontaneously into the right external auditory canal, and into the mouth. Accompanying one peak of temperature was a sharp deterioration of the President's condition, and the surgeons as well as the public abandoned all hope. Obituaries were prematurely published in England, on the strength of dire reports from Washington. The end was not yet, however, and the uncomplaining President's condition improved once more.

The details of the President's care are admirably related in the day to day account of his illness kept by Dr. Reyburn. The nursing duties were many, and in their performance the physicians were personally concerned. For the major portion of his illness Garfield was unable to turn himself, but with the aid of three people he was turned from fifty to seventy times per day, strong linen sheets placed beneath him being used for that purpose. Dr. Bliss spent only one night in his own home during the entire course of the President's illness, while Drs. Reyburn and Woodward alternated in spending their nights in the White House. The wound was dressed twice a day, morning and evening, at which times it was irrigated with 1 to 3 per cent phenol solution or solutions of potassium permanganate, 1:150 or 1:450. Injections along the wound track were made with ¼ of 1 per cent phenol solution. Morphine was administered freely at all stages of the illness, usually hypodermically, and quinine was given for fever. The feeding of the President was a matter of great concern, and in the various measures taken by the physicians one senses an intuitive realization of the need for a high protein intake in an easily assimilable form. Because of anorexia and frequent vomiting, it was necessary at first to rely on liquid food with occasional meals of solid food. Milk preparations, including notably koumiss, were given abundantly, together with Liebig's and Valentine's meat extracts. After almost six weeks of sepsis, the President's weight had fallen from 210 pounds to 130 pounds, and on August 14, rectal feeding was begun. This method was relied upon very largely, and sometimes entirely, for nutrition from that date until death. During the parotitis, for eight days, no other food or fluid was taken. The enemas were prepared from two ounces of beef extract (made by mincing and digestion of beef with water and hydrochloric acid), two drams of beef peptinoids, and five drams of whiskey, given every four hours day and night. To this mixture five to fifteen drops of deodorized tincture of opium were added. It was stated that no discomfort was experienced by the patient, and that he usually had but one formed stool daily. At first egg yolk was added, but "in the judgment of the surgeons, was the cause of annoying and offensive flatus."

The bulletin of 12:30 pm., August 20, 1881, seven weeks after the shooting, gives an idea of the extent of the treatment (9):

" . . . a small quantity of healthful pus came . . . after gentle pressure over the anterior surface of the right iliac region. This deeper part of the track was not reached by the tube until yesterday morning, when the separation of a small slough permitted it to pass, unresisted, downward and forward for the distance of twelve and one-half inches from the external surface of the last incision." Signed, Agnew, Bliss, Barnes, Woodward and Reyburn.

It is interesting, at this point, to consider the thoughts on the case entertained by an obscure member of the medical profession, whose opinion was neither asked for nor heeded. He was Dr. Frank Baker of Washington, then an assistant demonstrator of anatomy in the Medical Department of Columbian University, now the George Washington University School of Medicine. He was graduated from this school only the year before. Using knowledge of the case obtained by conversations with some of the surgeons in attendance upon the President, Baker carefully elaborated a diagnosis, which he revealed to several people on July 4, two days after the shooting and on July 7, presented it in full to several reputable physicians who attested later to its details (3). He claimed that the bullet had gone slightly downward and to the left, in the opposite direction from the one assumed by the President's attendants. We may list his points here:

" . . . (Considering the pain in the feet and scrotal symptoms—) the well-known maxim of Hilton, as to the diagnostic value of pain, is as follows: 'Superficial pains on both sides of the body, which are symmetrical, imply an origin or cause, the seat of which is central or bilateral; while unilateral pain implies a seat of origin which is one-sided, and, as a rule, exists on the same side of the body as the pain.'

" . . . It is observed that the pain in the feet was symmetrical, its cause was therefore central. The nerves of sensation for the feet being derived from the great sciatic nerve, the sensations denote a lesion of the spinal center connected with that nerve. This center is located by Malgaigne and Seguin opposite the body of the first lumbar vertebra. The sensation on the right side of the scrotum was not symmetrical, but unilateral; its origin, therefore, must be looked for on the same side of the body as the pain. The ilio-inguinal nerve is distributed to the cutaneous surface of the scrotum, and an injury to it at any point of its course could occasion the sensation noted . . . it also obtains some fibers of origin from a branch which passes from the twelfth dorsal to the first lumbar nerve, directly along the side of the body of the first lumbar vertebra.

"... The internal hemorrhage appeared from the symptoms to be very great. This indicated that some large artery was cut. The wound was too high for the right renal artery, the lumbar and suprarenal arteries are not large ... might be either the splenic or the pancreatic-duodenal branch of the superior mesenteric.

"... The portion of the liver below the lung is quite narrow, and lies well up under the arch of the diaphragm, conforming to it in shape. It would be quite possible for a ball to pass under this arch without wounding either liver or kidney.

"... The external hemorrhage was not sufficient to account for the gravity of the symptoms. Had the liver been wounded it is hardly possible that this should have been the case ... At the situation of the wound the liver is probably not covered by peritoneum ... A hemorrhage from its tissue would not be likely to escape into the peritoneal cavity.

"... It seemed impossible that a ball of the size used (calibre 44, weighing 200 grains, and impelled by 23 grains of powder), fired from so short a range, should not have gone through the body had there been nothing to oppose it but a rib and a mass of liver tissue of but little density.... The large column of the spine seemed the only structure which could offer resistance adequate to stop such a missile.

"... It was my opinion that the ball had possibly passed beyond.... (the vertebral body) ... and would be found in the tissue behind the peritoneum." (see diagram).

Dr. Baker inserts several other remarks into his article which indicate that he was influenced by less scientific, though perfectly reasonable, considerations. In the matter of Dr. Wales' opinion that he had probed the wound into the liver, Dr. Baker felt that the President's corpulence and the position of the wound would preclude a finger's reaching the distance. He knew that the assassin had stood on the President's right and had fired from right to left, indicating that the course in Garfield's body would be in the same direction. Of course, each of these points was a matter of common knowledge. Dr. Baker states that his diagram was prepared hastily and without recourse to a textbook. His statement, and the accompanying diagram, were certified as to accuracy and date of utterance by Drs. Prentiss, Townshend, and Lincoln, the last two members of the original group to attend the President. Regarding the fact that his work was never brought to the attention of the President's staff, Dr. Baker states "... I felt that it was improper to urge views which were diametrically opposed to those of gentlemen of acknowledged skill and experience who had had an opportunity of examining the wound."

The public had feared the "malarial airs" of Washington from the first; the Capitol's atmosphere was an object of national suspicion in that day. Garfield's physicians came to feel that perhaps the air was contributing to the slow recovery of their patient, and agreed upon a change of scene. During the period of his illness the daily environmental temperature had ranged from seventy to ninety degrees, with high humidity, which the President found exhausting. On July 18, a Mr. R. S. Jennings, of Baltimore, placed in operation an airconditioning apparatus which consisted of a fan in a subterranean chamber which drew in air and passed it over Turkish towels placed half an inch apart on wooden frames. The towels were kept wet with a solution of ice, water, and salt dripped on them from above. The apparatus furnished from eighteen to twenty-two thousand cubic feet of air per hour at a temperature from 54 to 56 degrees Fahrenheit; at the outlet of the flue in the President's room the temperature was 54 degrees, and during an outside temperature of 90 degrees the temperature was 75 degrees at the head of the President's bed, twenty feet distant.

The President was moved to Elberon, on the New Jersey seacoast, on September 5, 1881. With great care his bed was carried to a wagon and placed aboard a special train, his route attended by bare-headed well-wishers. Seven hours after leaving the White House he was comfortably lodged in the Francklyn Cottage, loaned to the President by its owner. Special tracks had been laid nearly from door to door. Almost immediately there was a noticeable improvement in the Chief Executive's condition, and he seemed to enjoy the sea air immensely. On the fourth day after their arrival, Dr. Hamilton said to Mrs. Garfield, "I am afraid to tell you how confident I feel of your husband's recovery." After this first period of improvement a relapse again developed. On September 17 the President had a chill and complained of "pain in his anterior mediastinum." This pain recurred at intervals of 6 to 7 hours until the end. For the first time the patient was hallucinated. There was slight improvement late on September 19, and the physicians retired for the night, leaving an aide, General Swaim, by the President's bedside. Ten minutes after the last had left, Garfield called to Swaim, and complained of a terrible pain, indicated by "a hand upon his heart." Dr. Bliss was called from an adjoining room at 10:10 p.m. and exclaimed, "My God, Swaim, he is dying; call Mrs. Garfield." No pulse was detectable, but feeble heart sounds were heard until 10:35 p.m. when Dr. Bliss pronounced the long-suffering Garfield dead.

The day following the President's death an autopsy was performed on his embalmed body, in the house where he died, by Acting Assistant Surgeon D. S. Lamb of the Army Medical Museum, whose report was signed by Bliss,

Barnes, Woodward, Reyburn and Lamb. The report is abstracted as follows (using the diagnostic terms of the prosectors):

1. The wound of entrance was represented by a depressed cicatrix over the tenth intercostal space, three and one-half inches to the right of the vertebral spines.

2. The right eleventh rib was fractured approximately three and one-half inches to the right of the transverse process of the 11th dorsal vertebra. The right twelfth rib was fractured at a point one and one-quarter inches to the right of the transverse process of the 12th dorsal vertebra.

3. The bullet passed obliquely to the left and forward, to the upper part of the body of the first lumbar vertebra, emerging on the left side of that bone and nicking the intervertebral disc separating it from the 12th dorsal vertebra. A number of minute bony fragments were driven into the adjacent soft tissues.

4. The spinal cord was not involved by the track of the ball. It presented no abnormal appearances.

5. Leaving the first lumbar vertebra, the bullet continued to the left, and passed behind the pancreas to the point, two and one-half inches to the left of the spinal column, where it was found, enveloped in a firm cyst of connective tissue, which contained, beside the ball, a minute quantity of inspissated, somewhat cheesy, pus.

6. For one inch proximal to the ball the track of the ball behind the pancreas was completely obliterated by the healing process. Thence as far backward as the first lumbar vertebra the track was filled with coagulated blood, which extended on the left into an irregular space rent in the adipose tissue, behind the peritoneum and above the pancreas. The blood had worked its way to the left bursting finally through the peritoneum behind the spleen, into the abdominal cavity. The mass of coagulated blood was nearly as large as a man's fist. The peripheral portion of the clot was disposed in pretty firm, concentric layers.

7. The tissues of the region of the hemorrhage were removed *en bloc* and minutely dissected after fixation. It was found that the fatal hemorrhage proceeded from a rent nearly four-tenths of an inch long in the main track of the splenic artery, two and one-half inches to the left of the celiac axis. This rent was felt to have occurred several days antemortem, since the everted edges of the slit in the vessel were united by firm adhesions to the surrounding connective tissue, thus forming an almost continuous wall bounding the adjoining portions of the blood clot. The immediate cause of death was secondary hemorrhage.

8. A long suppurating channel extended from the external wound between the loin muscles and the right kidney almost to the right groin. This channel, now known to be due to the burrowing of pus from the wound, was supposed during life to have been the track of the ball.

9. An abscess cavity six inches by four in dimension was found in the vicinity of the gall bladder. No communication was found between it and the wound.

10. The heart weighed 11 ounces. The muscular tissue was soft and tore easily.

The tissues were examined in part microscopically, but no complete account of this phase of the examination is given. The very important matter of the extent of the supposedly fatal intra-abdominal hemorrhage is not clearly dealt with. The autopsy protocol stated that the pelvis contained "rather more than a pint of bloody fluid," and a footnote adds that a large part of this was the embalmer's injection material. It is next stated: "A mass of black coagulated blood covered and concealed the spleen and the left margin of the greater omentum. On raising the omentum it was found that this blood-mass extended through the left lumbar and iliac regions and dipped down into the pelvis. . . . The blood coagula having been turned out and collected, *measured very nearly a pint*" (author's italics).

Thus two significant quantities of blood are described, that mentioned above, less than a pint in volume, and an organized clot "nearly as large as a man's fist." The total is approximately 750 cubic centimeters. It would seem that a hemorrhage of this magnitude would hardly be sufficient to produce sudden death. The prosector's conclusions seem even less tenable when their description of the clot adjacent to the splenic artery is examined. They state that the "peripheral portion of the clot in this vicinity was disposed in pretty firm, concentric layers." This description is that of an organized clot compatible with an origin two months before, at the time of the shooting. One is thus left with a conclusion that clotted blood of 500 cubic centimeter maximum volume represented a hemorrhage producing sudden death, and that this came from an arterial injury overlain by an organized blood clot. It is difficult to accept this proposition, though to deny it is to remove the comfort derived by Garfield's attendants in feeling that their patient would have died of a ruptured traumatic aneurysm whatever their treatment would have been.

If it is concluded that the President did not die of hemorrhage, what did cause his demise? It will be recalled that his death was sudden, and was immediately preceded by precordial pain. Intermittent "anterior mediastinal pain" had been noted in the last 48 hours. This arouses the suspicion that myocardial infarction may have been the terminal event. The heart is described as soft and easily torn, and no mention is made of the status of the coronary arteries. Prolonged sepsis and anemia would also produce myocardial softening, and anemia would aggravate any existing coronary artery disease. Pulmonary embolism is another possibility, but a less likely one. The history is not typical, there was no unusual activity just before the end, and a two-month course had already been weathered. The prosectors mention that there were no pulmonary infarcts, although they do not describe the contents of the pulmonary artery. Like myocardial infarction, pulmonary embolism was poorly understood at the time. In summary, it appears likely that President Garfield died from the effects of prolonged sepsis, with the possible addition of myocardial infarction terminally. The long-standing assumption that massive secondary

hemorrhage was the cause of death is not supported by the facts.

The conduct of the autopsy on President Garfield has been indirectly questioned by one observer, Dr. A. H. Smith. He was present at the request of someone with a legal turn of mind, since he was licensed in New Jersey and could have testified in the courts of that state on the findings, should that have been necessary. Writing on the subject 24 years later, Dr. Smith states that the autopsy was done by "Mr. Lamb . . . then a medical student," and that initially there was much confused searching for the bullet along the track postulated during life, after which the abdominal viscera were removed and thrown to one side. Dr. Smith claims that he went to the receptacle in which the removed viscera were lying and found the ball among them. His story does not find support in either fact or current account. Dr. Lamb was graduated from Georgetown Medical School in 1867 (1), and thus had been a physician for 15 years at the time of the autopsy, although he did not declare himself a pathologist until 1892, when he left Army service. No mention is made in the prosector's reports of who found the bullet, but it was obviously found by careful dissection, not by desultory examination of organs, as Dr. Smith implied. In his account, Dr. Smith also gives the impression that the removal of the abdominal viscera *in toto*, and their temporary storage, was indicative of carelessness, which is not justified, as anyone who is familiar with autopsy technique knows, and in reality, shows good judgment under the circumstances.

Other people criticized the attending surgeons for their failure to call in prominent and disinterested pathologists, which is perhaps justified, but does not necessarily indicate that the autopsy as performed was inadequate or done with ulterior motives.

Dr. Bliss was widely criticized for his handling of the case (2), and all who knew him felt that his life was shortened materially by his experiences; he followed Garfield to the grave eight years later. It is said that he refused admission to President Garfield's regular attendant, that he was never engaged as physician-in-charge by the President or Mrs. Garfield, and that he refused the aid of able men on arbitrary, and probably personal, grounds. In addition to these personal attacks, his professional judgment was questioned, cases were cited of similar injuries with recovery and authorities were quoted criticizing his treatment. On the other side, the majority supported him, as will be seen below.

Dr. Baker, the little-known anatomy assistant who had the doubtful satisfaction of seeing his diagnosis proved correct, never made any point of it, although other parties framed his diagram of the bullet's course and hung it in the Army Medical Museum. He later became Professor of Anatomy at Georgetown Medical School, superintendent of the Washington Zoo, and a prominent member of anthropological and anatomical societies (1).

Another sordid phase of this tragedy came in the payment of the claims submitted to Congress by the President's medical and nursing attendants (10). Seven individuals claimed a total of $91,000. The pathologist's claim for $1,000 was entirely disallowed. The remaining six received a total of $27,500, after "much acrimonious vituperation of the methods and motives of some of the claimants" (Tindall). The largest sum, $6,500, went to Dr. Bliss, who had claimed $25,000.

Alexander Graham Bell presented the details of his induction balance, which had been used with erroneous results on the President, to the Montreal meeting of the American Association for the Advancement of Science in 1882. Roughly, the device consisted of two electromagnets connected to a telephone receiver. When the fields of these magnets overlapped and a metal object was placed in the field, a click resulted. In its development he was assisted by numerous scientists and manufacturers. The first model was effective only up to 3.0 centimeters from the magnets, but it was improved until its range was 13.0 centimeters. It was this latter model which was used on Garfield, after the tests as mentioned here. Dr. Bell notes that in the first trial there was much interference as the result of metal bed springs beneath the patient's body, which he ordered removed for the second trial. Although this was done, there still remained metal parts in the mattress, which he overcame by lifting the magnets out of their range. Although not stated directly, he implies that only the right side of the President's body was explored, since the exploration of the left side would have indicated doubt of the attending physician's diagnostic abilities. Bell also notes that the President's corpulence placed the bullet, as eventually located at autopsy, out of the instrument's range. After Garfield's death, Dr. Bell continued to experiment with, and improve, the apparatus, and at a meeting in Dr. Hamilton's New York office, demonstrated it, using four public officials who carried in their bodies bullets received during the Civil War. The balance located them with 100 per cent accuracy,

although one was deep in the maxillary sinus. The instrument which was used by him in performing these tests had been completed at the time of Garfield's death.

It is interesting to speculate on Garfield's fate in various other circumstances. It is apparent that the many weeks of treatment were essentially directed against complications of the treatment itself. The vigorous and repeated probings with instruments and fingers, as well as injections of irritant antiseptics, undoubtedly spread infection and destroyed fascial barriers. The surgeons of the day, accepting hemorrhage from a traumatic aneurysm as the cause of death, felt that no matter what the treatment the outcome of the case would have been fatal. Since this conclusion seems untenable, the impression is gained that, had the President been but an ordinary citizen, less persistent treatment might have allowed recovery. The continued concern of the attending physicians over the whereabouts of the ball is one of the most puzzling facets of the whole story. At that time scores of Civil War veterans were alive and well with bullets in various parts of their bodies, and Garfield's attendants had ample precedent to disregard the ball.

The modern surgeon would probably experience little difficulty in dealing with this bullet wound. The location of the missile and the damage to the rib and vertebra would be quickly revealed by x-ray, perhaps with the additional help of an electronic foreign body localizer. These aids, coupled with the antibiotics, would assure a favorable outcome. It is even more interesting to speculate on the outcome had the injury occurred at the beginning of the 19th century, rather than at the dawn of modern abdominal surgery. The earlier surgeons would have lacked the courage to irrigate and incise, and their bleedings and poultices might have avoided the spreading of infection, which looms so large in the review of President Garfield's course.

In the interests of justice it is well to record here the opinions of the most famous surgeon of the day, and of one of the President's physicians. Dr. J. Marion Sims, said, "The President's surgeons did all that men could do, all that the present state of science would permit, and all that could have been done, even if they had first ascertained the course and direction of the ball ... Our whole medical literature does not contain a single well-authenticated case of recovery from such a wound" and "He had not the least chance of recovery under any circumstances or any treatment." In reading the monograph Dr. Reyburn wrote concerning his most famous case, one grasps what Dr. Alfred Worcester means when he says that the modern physician fails to participate emotionally and physically in the personal care of his patients. He points out that the doctors of several generations ago performed personal services that are now delegated to paid attendants, thus weakening a bond which, in a large measure, has built the high regard of the public for the medical profession. Dr. Reyburn's final paragraph, so obviously the product of deep feeling, is worth quoting at length.

"Finally, while it is difficult and perhaps impossible for any one to give a dispassionate judgment, in a case in which we were so deeply and personally interested as in that of the President, yet it is the deliberate conviction of the writer (as it was of all the surgeons in charge of the case) that the President was mortally wounded when he received the fatal shot. Freely confessing our errors of diagnosis, yet we believed that no different course of treatment could have saved his life. I know that I speak only the truth when I say that no wounded man ever received more tender, loving, and devoted service, not only from his surgeons but also from the faithful friends who nursed him through his long and weary illness. We gave him this cheerfully and would have sacrificed even our lives for him, if by so doing we could have saved his. We would have done this not only because he was President, but because we loved the man. Poor patient, uncomplaining, suffering President. How our hearts ached for him; Member of Congress, Senator, President, stricken down at a time when he had received in rapid succession the highest honors his country could bestow, he passed through days, weeks, and months of suffering, through the valley of the shadow of death, to that heavenly country, where there is neither suffering nor pain. We can not understand why such things should be. We can only bow in humble submission to the will of Him who ruleth all things both in heaven and earth, and who doeth all things, well."

Whatever the verdict of hindsight, one is certain that there was no lack of a deep personal feeling and strong sense of responsibility on the part of the attending physicians; they practiced to the utmost of their ability and with all of their energy. The present incumbent of the office could hope for no more devoted care, although more enlightened it would be.

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REVIEWS OF NEW BOOKS

THE new book *The Breast; Structure, Function, Disease*[1] edited by F. D. Saner, has 15 contributors. It is neither a treatise nor a compendium but an up-to-date comprehensive review of the structure, function, and diseases of the breast. There are suggestions from the group as to their methods of treatment. The excellent bibliography at the end of each chapter loses some of its effectiveness because there are only spotty references in the text.

In the chapter on diagnosis, physical examination is limited to the supine position. In the discourse on biopsy the author discusses biopsy for tumors of the nose and throat as well as the breast. There is mention of the use of radioactive substances, phosphorus and fluorescein as an aid in tumor differentiation. The surgical treatment of cancer is very brief and a footnote states: "the reader is referred to books on operative surgery." In contrast, the chapter on radiotherapy seems overdone. There are discussions on physics, dosage, and various types of technique.

The sections on embryology, histology, gross anatomy, and endocrinology are outstanding, not only in method of presentation but in completeness. One, if not the most interesting chapter, is that by R. S. Handley on the value of biopsy of the second mammary node as an aid in prognosis when there is minimal axillary involvement. The appendix of statistical data collected from many sources within the limits of figures gives the reader the opportunity to draw his own conclusions. It is an excellent finale to the volume.

The size makes for easy reading as does the excellent text. It is well illustrated with 200 illustrations some of which are in color. There is a place for this book in the library of every surgeon and, I am sure, that of the radiologist. J. E. KEARNS.

THE eleventh edition of *Nutrition in Health and disease*,[2] written primarily for student nurses, was first published in 1928. Since the science of nutrition has made such rapid progress and assumed a place of such importance in modern medical science, this revision is more than welcome, not only as a textbook but as a reference.

The book is written in 4 parts. Part 1, dealing with the principles of nutrition, has been revised. Included in it is a brief history of developments, which gave us our present day concepts of the science. Also included are new food value charts plus the 1948 revision of recommended dietary allowances by the National Research Council.

Part 2 deals with diet in disease and the current trends. Dietary departments using the American Dietetics Association's manual for teaching student nurses, prepared in 1949, will be glad to know that the dietary pattern followed in this book is essentially the same as that used in the manual. Special attention has been given to the low sodium diets now being used extensively in heart disease, hypertension, and kidney disease, and high protein diets for liver diseases and convalescence.

Part 3 covers food selection and preparation. An excellent selection of small quantity recipes is included, which should prove to be of great value not only to the student but also to the public health nurse in working out menus for families in the low income brackets.

Part 4 on tabular material and special tests includes many valuable revised tables plus excellent references covering all of the subjects dealt with in the book. The new classification of foods according to nutritive values plus revised figures on sodium content of foods should make this section useful not only to students but dietitians as well. For all those interested in the science of nutrition this should prove to be an excellent reference book.

E. THOMSON.

THE monograph *Cerebral Angiography*[3] should appeal to readers particularly interested in the neurological, neurosurgical, and experimental neurological specialties. In the author's own words, "This book is based on Moniz's published works, from which I quote freely, on his direct teaching and advice, and on my own experience of more than 2,000 cerebral angiographies, and twelve years of daily neurosurgical work."

The first 19 pages on technique alone constitute one of the most lucid explanations of angiography which is to be found in print. Apparently the manuscript was under preparation at various times, and though the book was printed in 1950, the author's preface gives the date of January, 1949, and the author indicates in several places that some of the details of his technique may have been altered since that date.

It is particularly important to note that he uses only the open technique, that is, he isolates the common carotid artery and injects it under direct vision, using local anesthesia. Furthermore, it is always the *common* carotid which he injects; he usually injects both carotids, and thorotrast is his medium for

[1] THE BREAST; STRUCTURE, FUNCTION, DISEASE. Edited by F. D. Saner, M.B., B.Ch. (Camb.), F.R.C.S. (Eng.). Baltimore: The Williams & Wilkins Co., 1950.

[2] NUTRITION IN HEALTH AND DISEASE. By Lenna F. Cooper, B.S., M.A., M.H.E., Sc.D., Edith M. Barber, B.S., M.S., Helen S. Mitchell, A.B., Ph.D., and Henderika J. Rynbergen, B.S., M.S. 11th rev. ed. Philadelphia, London, Montreal: J. B. Lippincott Co., 1950.

[3] CEREBRAL ANGIOGRAPHY. By P. Almeida Lima. Introduction by Egas Moniz and foreword by Sir Hugh Cairns, K.B.E., D.M., F.R.C.S. London, New York, Toronto: Geoffrey Cumberlege, Oxford University Press, 1950.

study. He has a specially made casette chassis which takes three views at intervals of 2 seconds each.

There is an excellent section on the normal angiogram and from it one can learn a great deal that is useful in the avoidance of misinterpretation of the varieties of pathology frequently seen on cerebral angiography. The various sections on the diagnosis of intracranial tumors, ventricular dilatation, intracranial vascular lesions, head injuries, and mental diseases are tersely and intelligently written. There is hardly a wasted word in this book which, though from a Portugese laboratory, apparently was written for this publication in English. The book is richly illustrated with photographs and line drawings, so that one can follow the gist of the variously described diagnostic techniques by studying the diagrams alone.

Very likely some of the technique and some of the interpretation of abnormal angiograms will be questioned by the occasional American reader, but everyone should agree that this is a valuable and timely contribution to a subject of much current interest, and that since the work is based on such an obviously large experience it could not be very wrong in any minor detail.

JOHN MARTIN.

THE volume *Pneumoconiosis; Beryllium Bauxite Fumes*[1] is the record of the sixth Saranac Symposium, held at Saranac Lake in the fall of 1947. It is dedicated to Leroy W. Gardner, who had made plans for this meeting before his death on October 24, 1946.

The first 454 pages give a full account of the clinical, chemical, and industrial aspects of the problem of *acute pneumonitis of beryllium workers* and the chronic, or delayed phase, *pulmonary granulomatosis of beryllium workers*. A general bibliography on beryllium containing 684 references up to January 1, 1950, is presented in an appendix.

Shaver's disease (pulmonary fibrosis, emphysema, and pneumothorax found among bauxite workers) is presented in 39 pages. This interesting section lacks some in clarity of presentation, and one might disagree in minor details with interpretation and positioning of the roentgenograms. However, these minor criticisms do not detract from the stimulating observations recorded by these scientists. These studies open the door to a vast new field of the effects of ultramicroscopic, chemically active substances retained in the lung.

Compensation for occupational diseases is presented from the medical, administrative, insurance, management, and medical referee's viewpoint in a section of 86 pages. While not as spectacular or scientific as the preceding sections, this segment raises many provocative questions.

This text should appeal to those interested in the newer developments in industrial medicine. This is the finest collection of data available, up through 1947, on the problem of beryllium and bauxite, as they affect the worker. The work presented is truly a monument to the memory of the outstanding scholar in this field, Dr. Leroy W. Gardner.

EUGENE L. WALSH.

IN presenting the fourth edition of his well known text, *Management of Obstetric Difficulties*[2] an outstanding teacher and clinician has effectively brought the material up to date. The changes, significantly enough, are predominantly in the field of treatment and patient management. The contemporary methods of managing threatened abortion, habitual abortion, the third stage of labor, bleeding and placenta previa are examples of the additions made in the current volume. More recent developments in obstetric pain relief are fully discussed.

It is also well, in evaluating a new edition, to consider those sections which are retained. Retained, fortunately, is the excellent section on the preparation of the patient and of the delivery room for delivery. It is refreshing to encounter this re-emphasis on meticulous individual technique in a day and age when a reliance on the availability of the antibiotics has on occasion contributed to technical negligence.

It should also be noted that with this edition Dr. Titus adopts terms and definitions which are, by prearrangement, to be standard among the leading American texts. Such co-operativeness among authors is not encountered often enough and should contribute to clearing up some of the confusion in our terminology.

The edition is well illustrated and well organized, and this remains a helpful and useful text.

ALLAN C. BARNES.

A PORTRAYAL of the times, the life and the works of Ignaz Philipp Semmelweis, one of medicine's neglected immortals, has been long overdue. In *Immortal Magyar*,[3] Frank G. Slaughter has presented in a straightforward, narrative style the tragic story of Semmelweis' fight for recognition of the principles of asepsis in obstetrics and surgery. He relates how Semmelweis, antedating Pasteur and Lister, demonstrated in meticulously performed experiments, the transmission of exogenous infections in the lying-in ward and the operating room.

Although Semmelweis has been known primarily as the discoverer of the cause of puerperal fever the reader of *Immortal Magyar* is impressed with the fact that his greatest contribution was in proving the effectiveness of surgical cleanliness in reducing the appalling mortality of the early nineteenth century maternities. Throughout the narrative runs the thread

[1] PNEUMOCONIOSIS; BERYLLIUM BAUXITE, FUMES. Edited by Arthur J. Vorwald, M.D., with the collaboration of Manfred Bowditch, A.B., Thomas M. Durkan, M.E., and Theodore C. Waters, L.L.B. 6th Saranac Symposium. New York: Paul B. Hoeber, Inc., Medical Book Department of Harper & Brothers, 1950.

[2] THE MANAGEMENT OF OBSTETRIC DIFFICULTIES. By Paul Titus, M.D., 4th ed. St. Louis: The C. V. Mosby Co., 1950.

[3] IMMORTAL MAGYAR; SEMMELWEIS, CONQUEROR OF CHILDBED FEVER. By Frank G. Slaughter, M.D. New York: Henry Schuman, Inc., 1950.

of Semmelweis' fanatical battle against academic and political persecution. Despite the fact that throughout his life his teachings were ignored and ridiculed he continued to fight for the truth he knew until he died of septicemia and madness, still unaccepted.

A martyr to the ignorance and stupidity of the world of his day, Semmelweis' story is a dramatic illustration of brilliant scientific achievement smothered by the jealousies of his government appointed superiors. Rejection of his doctrines by the dogmaticists of his time is reflected even today in the relatively lesser recognition he has been accorded in the history of obstetrical and gynecological surgery.

Dr. Slaughter, surgeon and author, has told the story of Semmelweis' life simply and ably. It is a book which makes enjoyable reading for anyone interested in medicine. It is a thought-provoking contribution for those who are concerned over governmental meddling in medicine. It is a valuable addition to the medical biographical literature.

JOHN W. HUFFMAN.

THE 427 page book by Doctors Rankin and Graham, *Cancer of the Colon and Rectum, Its Diagnosis and Treatment*,[1] covers the field completely. The sections on anatomy and physiology are clear, concise, and adequately illustrated. The chapters on the incidence, occurrence and etiology, pathology, symptoms and diagnosis, and differential diagnosis are clear and well illustrated.

The remaining sections devoted to a consideration of treatment and operative procedures are timely. In these sections the authors present data collected from numerous clinics and individual surgeons who have been interested in this problem. From this material a clear idea of the present practice in treating cancer in the various portions of the large bowel is given. All controversial subjects are clearly stated, reviewed, and presented. This material is not available in similar form elsewhere and every surgeon who is interested, even casually, in cancer of the colon or rectum should be thoroughly familiar with the data presented in this volume.

R. K. GILCHRIST.

THE book *Biological Standardization*,[2] called a second edition, the first by this title having appeared in 1937, is essentially the third edition by the senior author as his *Methods of Biological Assay* which appeared in 1928 was the forerunner to this series. For all of these years the books by Burn have occupied a prominent place in the pharmacologist's library. Since biological standardization is concerned with potency measurement of those agents which cannot be determined by standard chemical and physical techniques it is to be expected that its field would narrow as the isolation and chemical identification of the active principles of crude materials progresses. Nevertheless, we find that this volume is larger than its predecessors. Ergot is perhaps the conspicuous example of a drug whose biological standardization was a challenging task when the first edition was current and which is not included in the present volume because the utilization of the active principles (standardizable by chemical means) has largely superseded the use of the crude drug. But to our old friends the digitalis principles, insulin, and other hormones, which were in the first edition and are also in the current edition, have been added curare principles and newer hormone and vitamin preparations, all requiring biological standardization. The increasing net size of the field with which biological standardization is concerned is thus a cogent commentary upon the rapid growth in medical research.

As the methods of biological assay have developed, an increasing necessity for the application of statistical procedures has appeared. The current volume contains some 150 pages of statistical material, which will be found valuable by workers in the biological sciences whether or not they have a specific interest in biological standardization per se.

Surgeons who read this text may regret the absence of consideration of heparin, thrombin, and other thromboplastic agents.

CARL A. DRAGSTEDT.

THE second edition of the book formerly called *Industrial Ophthalmology* has been published under the title *Eyes and Industry*.[3] Although the title is new the contents are essentially the same except for a regrouping of some of the material and the addition of 80 pages.

The book is divided into 11 chapters. The first chapter deals with visual testing in industry, and it contains information on how to launch a visual testing program, the instruments in common usage, and the tests employed.

The second and third chapters are concerned with visual skills and standards as they apply to particular jobs. The functions of acuity, stereopsis, color appreciation, near vision, and co-ordination are needed and they may even be the necessary requirements for excellent work in certain jobs. Substandard visual skills often account for substandard performance and visual data are valuable and necessary to management in selecting the proper worker for a specific job.

Chapter 4 deals with corrective programs and refraction with reference to the occupation, giving emphasis to both diagnosis and treatment. Chapter 5 is concerned with industrial eye injuries caused by solid bodies. Dr. Snell is the author of this chapter and it contains considerable information on first aid, diagnosis, and the treatment of eye injuries. The

[1] CANCER OF THE COLON AND RECTUM; ITS DIAGNOSIS AND TREATMENT. By Fred W. Rankin, B.A., M.A., M.D., LL.D., Sc.D., F.A.C.S., and A. Stephens Graham, M.D., M.S., F.A.C.S. 2d ed. Springfield, Ill.: Charles C Thomas, 1950.

[2] BIOLOGICAL STANDARDIZATION. By J. H. Burn, D. F. Finney, and L. G. Goodwin. 2d ed. London, New York, Toronto: Geoffrey Cumberlege, Oxford University Press, 1950.

[3] EYES AND INDUSTRY; FORMERLY INDUSTRIAL OPHTHALMOLOGY. By Hedwig S. Kuhn, M.D. 2d ed. St. Louis: The C. V. Mosby Co., 1950.

rest of the book is devoted to radiation, chemical eye injuries, illumination, the blind in industry, and eye protection. In the latter chapter there is a good description of goggle types and goggle programs.

The book is well illustrated and it contains much material which is of benefit to those interested in or doing industrial medicine. IRVING PUNTENNEY.

THE text *Cytology of the Human Vagina*[1] has been translated from the original Spanish by George W. Corner, M.D. The authors have accumulated an extensive amount of data during an approximate 5 years of study on 200 women. Prior to undertaking this project, Dr. Allende "studied the reproductive function in women with Ephraim Shorr of Cornell University Medical School in New York City, and in the rhesus monkey with Carl G. Hartman and George W. Corner in Baltimore."

Their purposes in the investigation were to apply the Shorr trichrome stain to vaginal smears; to elaborate the human vaginal cycle so as to establish a normal for comparison with abnormals; to give in detail the characteristic changes which indicate functional alterations of the sex cycle in the female; and to be a guide for others who wish to make these studies. The chapters are defined as to aims. Only that amount of space for technique is allotted which will enable the interested physician to obtain the best results.

There are illustrative photomicrographs in color. Graphs and tables are used to clarify where necessary. The prose reads easily. Adequate references are included at the end of the volume. The book has been printed in large type on soft paper and there are numerous subheadings.

This is an extremely useful book for endocrinologists, gynecologists, cytologists, pathologists, and any others who are anxious to learn more of this subject. It is recommended for wide use and will probably be extensively quoted in the future.

M. C. WHEELOCK.

IT is now over 400 years from the date of Vesalius' *Fabricus*, and while that is the date of the beginning of modern anatomy, and also though it is frequently stated that there is no longer anything new in gross anatomy, Anson's splendid *Atlas of Human Anatomy*,[2] which is the culmination of 20 years of painstaking collection of firsthand data, is evidence that for the determined anatomist there is always something new.

Here is in every sense a new atlas of human anatomy, for in it nothing has been borrowed, every one of the illustrations in the 518 pages having been prepared especially for this volume by a selected group of competent medical illustrators. The text is lean and explicit, and it is on the page or adjacent page with the illustration described. The use of color is limited, allowing a price of this book which makes it available to a wide group of purchasers. The line drawings and half-tones are prepared with such unusual effect that the dissections stand out with great clarity. The body is considered by regions which, of course, makes it valuable for practical use by both the student at work with a cadaver and by the practicing surgeon. The treatment of muscle and fascial planes is especially effective. The labels for the various structures are all in accurate Latin, and in this respect the labeling is a welcome aid in training students to use accurate terminology. The illustrations have a certain freshness and clarity which have left no place for confusing, irrelevant details. The variations in fascial planes, vascular supply, and certain organ relationships are demonstrated, based on a large number of specially made dissections, and the percentage of the possible variations is frequently stated for the welcome aid to the surgeon in his practical application of living anatomy and its common variations. It is reassuring to realize that the great and fundamental subject of gross human anatomy still can be treated with detailed introspection and without any compromise with the fixed and sometimes erroneous statements of older standard texts.

The book is beautifully printed on heavy enamel paper, ruggedly bound, and lies open in a flat manner as an atlas should and as an atlas need do for use at the dissection table. Without question the book will have a deservedly wide use.

JOHN MARTIN.

TWENTY-FIVE authors collaborate to cover the field of internal medicine from the point of view of disturbed physiology in the book *Pathologic Physiology; Mechanisms of Disease*.[3] The attempt is made to bridge a gap between standard tests of physiology and medicine by analyzing the symptoms and signs of disease and the mechanisms of their development. Sections are devoted to the circulatory, respiratory, digestive, and locomotor symptoms; to the blood and spleen; the urinary tract; to the endocrine glands, water balance, and nutrition; to infectious diseases and allergy, and to physical, toxic, and chemical agents. The more recent advances in knowledge of physiology that are applicable to medicine are included. The book will be of interest to all internists. WALTER H. NADLER.

THE book *Thoracic Surgery*[4] by Richard H. Sweet is an important contribution to the literature of this rapidly expanding branch of surgery. It is essentially an authoritative presentation of the modern techniques of surgery of the chest. As Dr. Sweet has made many contributions of his own,

[1] CYTOLOGY OF THE HUMAN VAGINA. By Ines L. C. De Allende, M.D., and Oscar Orias, M.D. With a foreword by Bernardo A. Houssay, M.D. New York: Paul B. Hoeber, Inc., Medical Book Department of Harper & Brothers, 1950.

[2] AN ATLAS OF HUMAN ANATOMY. By Barry J. Anson, Ph.D. Philadelphia, London: W. B. Saunders Co., 1950.

[3] PATHOLOGIC PHYSIOLOGY; MECHANISMS OF DISEASE. Edited by William A. Sodeman, M.D., F.A.C.P. Philadelphia, London: W. B. Saunders Co., 1950.

[4] THORACIC SURGERY. By Richard H. Sweet, M.D. Philadelphia, London: W. B. Saunders Co., 1950.

notably in regard to surgery of the esophagus, this book has the added weight of his personal experience.

In this book the author gives a very clear anatomical background for all of the operations described, and the excellent illustrations by Arroyo add greatly to the lucidity of the text. Sweet describes in satisfactory detail the operative procedures which have been used by him, and are in common use throughout the world. He has omitted discussion of procedures that are still in an experimental stage, and has wisely not taken up valuable space in describing outmoded operations. As Dr. Sweet states in his preface, the satisfactory performance of thoracic operations can be carried out by any well trained surgeon, and it is equally true that they cannot be performed by a surgeon who has not been well trained in general surgical principles. With these statements no one can disagree, but there is the real danger that technical ability, aided by such a beautiful book on technique as this one, may tempt some surgeons to dabble in thoracic surgery. This reviewer is sure that Dr. Sweet had no such intentions.

Even in such a fine book as this one there are certain points with which the reviewer does not entirely agree, or which seem to him to need amplification. In discussing thoracentesis, a simple procedure of great value, Sweet rightly points out the fallacy of the old superstition about the danger of allowing air to enter the chest during the operation. Indeed, by gradual, partial replacement of the fluid with air one can completely empty the pleural cavity without upsetting the patient. Except in cases of diffuse, suppurative pleurisy or of traumatic hemothorax, this should be done for therapeutic and diagnostic reasons. Roentgenograms of the chest taken after this is done will reveal the outline of the surface of the lung, the diaphragm, and chest wall not possible otherwise. Tumors thus become visible.

In discussing the use of local anesthesia for thoracoplasty Sweet says that it can be satisfactorily used for the second and third stages, but not for the first. In an experience covering 15 years this reviewer has had just the opposite results. Local anesthesia for the first stage has always been almost universally satisfactory, while difficulties have been encountered in the secondary stages.

One final point that seems to need amplification concerns a procedure about which there is still much controversy. This is extrapleural plombage. Few, if any, of its users advocate it for the collapse of large cavities. In the performance of the operation one first establishes an extrapleural space comparable with that used for extrapleural pneumothorax. This space is then gradually filled with softened paraffin without causing active pressure on the underlying lung. The pack, in properly selected cases, should never give trouble, and is never removed unless the underlying lung is to be treated by thoracoplasty or by resection. The great extension of the use of segmental lobectomy in the treatment of tuberculosis will undoubtedly relegate this procedure even further into the background.

There has been a growing need for such a book as this for many years. There have been a few excellent works dealing with certain aspects of chest surgery, but none since Lilienthal's two volumes on the subject in 1925 have even attempted to cover all of the techniques of thoracic surgery. This book thoroughly describes every thoracic surgical procedure of established value, and so meets a great need. However, Sweet does not discuss the physiological problems of the chest, nor does he cover the diagnosis and general management of the diseases and conditions for which the operations are performed. No book since the monumental work of Graham, Singer, and Ballon, on *Surgical Diseases of the Chest*, published in 1935, has done this. Since then the horizon of thoracic surgery has been greatly extended. Sweet's book is thus a timely one and will be welcomed by everyone who is interested in this branch of surgery. However, there still is need for a new edition of *Surgical Diseases of the Chest*, or for a new volume covering the same subjects.

RICHARD H. MEADE, JR.

AS the author states in his introduction, much of the material in the volume *Surgery of the Eye—Injuries*[1] is based on experiences gained in handling eye injuries during World War II. This extensive experience has been applied to civilian injuries and thus is time tested as to practical results. It is a unique and all inclusive test of traumatic eye problems in that it discusses the handling of simple foreign bodies of the cornea and then all the way to enucleation of the globe. Here, particular attention is paid to the newest methods of treatment, instrumentation, implants, and prostheses.

While many different methods are not discussed, at least one very simple approach is beautifully described and illustrated for the handling of almost every possible eye injury with particular attention to preoperative and postoperative care. The chapters on plastic procedures, including grafts, deserve particular attention since no stone is left unturned in describing the many approaches to this difficult cosmetic problem.

The illustrations and diagrammatic depicting of every surgical detail make each procedure vividly clear and concise. In summary, this book is a well written and beautifully illustrated text devoted to the subject of traumatic surgery.

HEDWIG S. KUHN.

TO be honored and to be held in high esteem by one's colleagues are the highest rewards that can come to a surgeon, and the volume of contributions on many different phases of surgery, presented to Dr. Gallie on the occasion of his retirement from the chair of Surgery in the University of Toronto, attests the place that he has attained in the minds and hearts of his students and colleagues.

[1]SURGERY OF THE EYE—INJURIES. By Alston Callahan, B.A., M.S. (Ophth.). M.D., F.A.C.S., Springfield, Ill.: Charles C Thomas, 1950.

It is appropriate that among these 43 papers in *Essays in Surgery*[1] there should be a number from the staff of the Childrens Hospital, for it was to the Childrens Hospital that Dr. Gallie returned after he had completed his internship at the Hospital for Ruptured and Crippled in New York. There he began his surgical career, first as resident, then as junior surgeon and, upon the appointment of his senior, Dr. Clarence Starr, as Professor of Surgery, as Surgeon-in-Chief.

Among the papers concerned with the surgery of childhood is an excellent and thoughtful discussion of the operative treatment of cleft palate by his colleague of many years, A. B. LeMesurier who was associated with Dr. Gallie in carrying out some of the experimental and clinical work for which he is best known, the use of fascia and tendon as suture material in the repair of hernia of other disabilities and anatomical defects. Papers by A. W. Farmer on congenital webbing of the neck, by F. Robert Wilkinson on congenital atresia of the esophagus with tracheoesophageal fistula, by Stuart A. Thompson on diaphragmatic hernia in children and by R. M. Wansbrough on congenital hypertrophic pyloric stenosis indicate the constant and persisting interest which exists in the surgery of childhood at the University of Toronto.

Among so large a group of excellent papers representing practically every field of surgery it is difficult, almost unfair, to single out any for special mention. J. E. Bateman's well illustrated paper on peripheral nerve injuries, a report of a most unusual and successfully treated case of bilateral chromaffinoma of the adrenal glands by D. R. Mitchell and S. J. Shane, Harold Wookey's report upon radical excision of the upper and lower jaw for malignant disease, Jessie Gray's discussion of biochemical disturbances accompanying gastroduodenal disease and William Boyd's very illuminating and informative description of the spread of tumors are only a few of a large group of papers that reflect the scope and excellence of the surgical work which is being carried on at the University of Toronto and its associated hospitals. Together they reflect great credit upon one of the important medical centers of this continent and constitute an outstanding and appropriate tribute to the man who has taken the leading part in its department of surgery for so many years.

SUMNER L. KOCH.

[1] ESSAYS IN SURGERY. Presented to Dr. W. E. Gallie on the Occasion of his Retirement from the Chair of Surgery in the University of Toronto. Toronto: University of Toronto Press, 1950.

BOOKS RECEIVED

Books received are acknowledged in this department, and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

DIE TUBERKULOSE, IHRE ERKENNUNG UND BEHANDLUNG. By Prof. Dr. Hellmuth Deist and Prof. Dr. Hermann Drauss. Stuttgart: Ferdinand Enke, 1951.

ENGLISH-GERMAN MEDICAL DICTIONARY. Compiled by F. S. Schoenewald, M.D. Philadelphia, Toronto: The Blakiston Co., 1951.

MALIGNANT DISEASE OF THE FEMALE GENITAL TRACT. By Stanley Way, M.R.C.O.G. Philadelphia: The Blakiston Co., 1951.

THE STUDENT'S HANDBOOK OF SURGICAL OPERATIONS. By Sir Frederick Treves, Bart. G.C.V.O., C.B., LL.D., F.R.C.S., 9th ed. revised by Sir Cecil Wakeley, K.B.E., C.B., D.Sc., P.R.C.S., F.R.S.E., F.A.C.S. (Hon.), F.R.A.C.S. New York: Paul B. Hoeber, Inc., Medical Book Department of Harper & Brothers, 1951.

CANCER AS I SEE IT. By Henry W. Abelmann, M.D., New York: Philosophical Library, 1951.

A SYNOPSIS OF SURGICAL ANATOMY. By Alexander Lee McGregor, M.Ch.(Edin.), F.R.C.S. (Eng.). With a foreword by Sir Harold J. Stiles, K.B.E., F.R.C.S. (Edin.). 7th ed. Baltimore: The Williams & Wilkins Co., 1950.

LEHRBUCH DER GEBURTSHILFE. By Professor Dr. Karl Burger. Berlin, Goettingen, Heidelberg: Springer, 1950.

MODERN MEDICINE ANNUAL 1951. An annual volume containing the articles that appeared in the twenty-four issues of *Modern Medicine* during 1950. Minneapolis: Modern Medicine, 1951.

AN INTRODUCTION OF THE STUDY OF VIRUSES. By Kenneth M. Smith, F.R.S. New York, Toronto, London: Pitman Publishing Corporation, 1950.

CLINIQUE THÉRAPEUTIQUE GYNÉCOLOGIQUE (TROUBLES FONCTIONNELS EXCEPTÉS). By Gaston Cotte and Jacques Mathieu. Paris: Masson et Cie, 1951.

DIE ENTZUENDUNGSBESTRAHLUNG. By Dr. Med. Habil. R. Glauner. No. 2. Stuttgart: Georg Thieme, 1951.

DIE FRUEHDIAGNOSE DES UTERUSCARCINOMS; UNTER BESONDERER BERUECKSICHTIGUNG DES SCHEIDENABSTRICHVERFAHRENS NACH PAPANICOLAOU. By Prof. Dr. Med. Hans Limburg. Stuttgart: Georg Thieme, 1950.

LEHRBUCH DER ROENTGENDIAGNOSTIK. By H. R. Schinz, W. E. Baensch, and E. Friedl, E. Uehlinger. 5th rev. enl. ed. No. 3, Skelett. Stuttgart: Georg Thieme, 1951.

LES DOULEURS DE L'ACCOUCHEMENT ANALGÉSIE ET ANESTHÉSIE. By Henri Vignes. Paris: Masson et Cie, 1951.

SURGICAL FORUM; Proceedings of the Forum Sessions Thirty-Sixth Clinical Congress of the American College of Surgeons, Boston, Massachusetts, October, 1950. Surgical Forum Committee: Owen H. Wangensteen, M.D., F.A.C.S., Minneapolis, chairman, Warren H. Cole, M.D., F.A.C.S., Chicago, Robert E. Gross, M.D., F.A.C.S., Boston, Michael L. Mason, M.D., F.A.C.S., Chicago, Carl A. Moyer, M.D., F.A.C.S., Dallas, I. S. Ravdin, M.D., F.A.C.S., Philadelphia. Philadelphia, London: W. B. Saunders Company, 1951.

CLINICAL CONGRESS OF AMERICAN COLLEGE OF SURGEONS

PRELIMINARY PLANS FOR 1951 CLINICAL CONGRESS OF THE AMERICAN COLLEGE OF SURGEONS SAN FRANCISCO, CALIFORNIA—NOVEMBER 5 TO 9, 1951

THE Thirty-seventh Clinical Congress of the American College of Surgeons will be held in San Francisco, California, from November 5 to 9, 1951. Registration headquarters will be at the Civic Auditorium. Meetings will be held there and at the Fairmont, St. Francis, and Mark Hopkins hotels.

Plans are under way for a complete and varied program for the 5 day meeting. The hospitals and medical schools will co-operate in scheduling operative clinics and demonstrations. It is anticipated that color television will again be available from one of the hospitals in order that surgery at the time it is being performed may be viewed by a much larger number of visiting surgeons than would be possible in the comparatively limited accommodations in the surgical amphitheaters of the hospitals in San Francisco.

PRESIDENTIAL MEETING AND CONVOCATION

The opening evening session of the Clinical Congress will be devoted to the Presidential Meeting, at which the officers-elect will be installed—Dr. Alton Ochsner of New Orleans as President, Dr. Thomas H. Lanman of Boston as First Vice President, and Dr. Joel W. Baker of Seattle as Second Vice President. Dr. Henry W. Cave of New York, President, will preside and will deliver the Presidential Address. The sixth Martin Memorial Lecture will also be included in this program.

The annual Convocation will be held on the final evening, Friday, with formal initiation ceremonies and the presentation of the Fellowship Address.

SCIENTIFIC SESSIONS

Scientific sessions will, as usual, be held on Tuesday, Wednesday, and Thursday evenings, and will include separate meetings for specialists in ophthalmology and otorhinolaryngology. Panel discussions will be held every afternoon, Monday through Thursday, with panels on the surgical specialties on Friday afternoon. Symposia on trauma, on cancer, and on graduate training in surgery are planned.

FORUM ON FUNDAMENTAL SURGICAL PROBLEMS

The Forum on Fundamental Surgical Problems will again be featured in ten or more sessions in which there will be presented brief reports of original clinical and experimental observations relating to the broad aspects of general surgery and the surgical specialties.

CINÉ CLINICS AND OTHER MEDICAL MOTION PICTURES

The Ciné Clinics which proved to be so popular at the 1950 Clinical Congress in Boston will be repeated in 1951 if present negotiations develop.

The latest available pictures on surgery and related subjects will be presented. Special showings will be arranged of films in the fields of ophthalmology and otorhinolaryngology. The Medical Motion Picture Committee will start choosing films for the Congress at an early date. Pictures that have been recently produced should be forwarded to the College for immediate review as it is the policy to include only those films which were submitted in time to obtain approval by the Committee on Medical Motion Pictures.

ADVANCE REGISTRATION AND HOTEL RESERVATIONS

A letter will be sent to all Fellows of the College in June of 1951, outlining the registration procedures to be followed, as well as giving full information and forms to be used in securing hotel reservations. The officials of the College feel that sufficient hotel accommodations will be available in the City of San Francisco to care adequately for everyone, so that a situation such as prevailed in Boston will not again inconvenience the Fellows.